Printed on Thin Paper for Foreign Circulation.

MAR 21 1924

Engineering Library

The Engineer.

Established 1856.

Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXXXVII.—No. 3558] LONDON: FRIDAY EVENING, MARCH 7, 1924 [PRICE {WITH SUPPLEMENT} ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The Director-General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, REQUIRES :—
MOTOR-DRIVEN AIR COMPRESSOR.
Tenders due on the 28th March, 1924.
Tender forms obtainable from above. 5153

Ipswich Education Committee.
SCHOOL OF ENGINEERING.
APPLICATIONS are INVITED for the POST of PRINCIPAL. Candidates must be good organisers, well qualified in Engineering Subjects, and have had actual Works Experience. Salary will be at the rate of £150 per annum for part-time service, as shown in the list of duties. The session extends from October to April, and the school will be open on three evenings per week. The person appointed will be required to reside within the borough.
Form of application, returnable not later than the first post on the 12th March, together with the list of duties, will be forwarded on receipt of a stamped addressed envelope.
Selected applicants will be interviewed on Friday afternoon, the 14th March.
H. ARMITAGE,
Secretary for Education.
Tower House, Ipswich. 5104

Great Northern Railway (Ireland).
SECOND-HAND MACHINERY FOR SALE.
The Directors are prepared to receive TENDERS for the PURCHASE of the following SECOND-HAND MACHINERY :—
ONE PORTABLE ENGINE, Brown and May, single cylinder, 10in. diameter by 16in. stroke.
ONE DITTO, Garrett and Sons, single cylinder, 7in. diameter by 12in. stroke.
ONE DITTO, Robertson and Auden, single cylinder, 7in. diameter by 12in. stroke.
ONE TRACTION ENGINE, J. Fowler and Sons, nominal H.P. 8 to 10.
ONE UPRIGHT LOG SAW (self-contained), steam or belt driven, cylinders 12in. by 24in., to take logs up to 26in. square or diameter : makers, Thomas Robinson and Sons.
The log saw can be seen on application to the Company's Locomotive Engineer, Dundalk, and the engines on application to the District Engineer, Dundalk.
Tenders, made out on forms supplied by the Company, should be delivered, under sealed cover, endorsed "Tender for Machinery," to the undersigned, not later than 10 a.m. on 26th March, 1924.
The Directors do not bind themselves to accept the highest or any Tender.
J. B. STEPHENS,
Secretary.
Amiens-street Station,
Dublin, 27th February, 1924. 5102

Great Northern Railway (Ireland).
The Directors are prepared to receive TENDERS for the SUPPLY of
ONE 40-TON WELL WAGON,
in accordance with the drawings and specification, copies of which can be obtained on application to the undersigned, on payment of £1, which will be refunded on receipt of a bona fide Tender, and on return of the drawings and specification.
Tenders, made out on the forms supplied by the company, should be delivered, under sealed cover, endorsed "Tender for Well Wagon," not later than 10 a.m. on 27th March, 1924.
The Directors do not bind themselves to accept the lowest or any Tender.
J. B. STEPHENS,
Secretary.
Amiens-street Station,
Dublin, 29th February, 1924. 5103

Great Northern Railway (Ireland).
TENDERS FOR SLEEPERS.
The Directors are prepared to receive TENDERS for SUPPLY of BALTIC REDWOOD SLEEPERS, 9ft. by 10in. by 5in.
Tenders, made out on the forms supplied by the Company, should be delivered, under sealed cover, endorsed "Tender for Sleepers," to the undersigned, not later than 10 a.m. on Monday, 31st March, 1924.
The Directors do not bind themselves to accept the lowest or any Tender.
J. B. STEPHENS,
Secretary.
Amiens-street Station,
Dublin, 4th March, 1924. 5125

Great Northern Railway (Ireland).
TO BRIDGE CONTRACTORS.
The Directors are prepared to receive TENDERS for the RECONSTRUCTION and ERECTION of a STEEL UNDERLINE BRIDGE and CYLINDERS, between Nowbliss and Clones.
The drawing and specification may be inspected at the Engineer's Offices, Dublin and Belfast, and copies of same, together with bills of quantities and forms of Tender, may be obtained from the undersigned on payment of Two Guineas, which will be refunded on receipt of a bona fide Tender and return of the drawings.
Tenders, made out on the forms supplied by the company, should be delivered under sealed cover, endorsed "Tender for Bridge," not later than 10 a.m. on Saturday, 22nd March, 1924.
The Directors do not bind themselves to accept the lowest or any Tender.
J. B. STEPHENS,
Secretary.
Amiens-street Station,
Dublin, 4th March, 1924. 5124

Newton Abbot Rural District Council.
KINGSTEIGNTON WATER SUPPLY.
TENDERS are INVITED for LAYING about 5260 Yards of 6in. and 521 Yards of 4in. CAST IRON WATER MAINS, and also PROVIDING and FIXING all SPECIALS and Works in connection with the above undertaking.
Drawings may be seen and copies of specifications and bills of quantities and forms of Tender obtained, at my office on payment of the sum of £2 2s., which will be returned upon receipt of a bona fide Tender and the return of all documents.
Tenders, endorsed "Kingsteignton Water Supply," to be delivered at my office not later than Ten o'clock on Saturday, the 22nd March, 1924.
The lowest or any Tender not necessarily accepted.
By Order,
F. HORNER,
Clerk.
Council Offices,
64, East-street, Newton Abbot,
27th February, 1924. 5096

The Engineer

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The Work-Hardening of Metals.

Engineering in Literature.

The Power Station at the Empire Exhibition.

Sydney Harbour Bridge.

The Rastricks—Civil Engineers.

Practical Hydraulic Engineering Problems.

Apparatus for Protecting Alternating Current Circuits.

PUBLIC NOTICES

Bombay, Baroda, and Central India Railway Company.
The Directors are prepared to receive, up to Noon on Friday, 21st March, TENDERS for the SUPPLY of WHITE LEAD.
Tenders must be made on forms, copies of which, with specification, can be obtained at these Offices on payment of 10s. each (which will not be returned).
The Directors do not bind themselves to accept the lowest or any Tender.
S. G. S. YOUNG,
Secretary.
Offices : 91, Petty France, Westminster, S.W. 1.
5th March, 1924. 5137

Borough of Durban, Natal.
SHONGWENI WATER SCHEME.
VERNON HOOPER DAM.
TENDER FOR LARGE SLUICE VALVES, VALVE TOWER IRONWORK, PIPES, &c.
The Corporation of Durban invite TENDERS for the SUPPLY and DELIVERY of the following :—
(1) 15 Large NEEDLE VALVES, or TORPEDO SLUICE, with Operating Gear, and Steel or C.I. Lining for Sluiceways, with appurtenant Ironwork.
(2) TRAVELLING CRANE, CUT-OFF SPHERES, TRUCKS, SCREENS, STANDPIPES, &c.
(3) CAST IRON PIPES, VALVES, VENTURI METER for Sphere Pumps, and CAST IRON SPECIAL PIPES, &c., in accordance with drawings and specifications prepared by—
Mr. Walter M. Campbell, M.Inst.C.E., M.I.Mech.E., Borough Water Engineer, Durban.
Copies of the specification, drawings, and form of Tender, may be obtained from Messrs. Webster, Steel and Co., 5, East India-avenue, London, E.C., upon payment of a deposit of Five Guineas, returnable only after a bona fide Tender has been received and duly considered.
Sealed Tenders, addressed to the TOWN CLERK, Durban, marked outside "Tenders for Sluice Valves, &c., Vernon Hooper Dam," will be received at the Town Clerk's Office, Durban, until 11 a.m. on Friday, 2nd May, 1924. 5138

State Electricity Commission OF VICTORIA.
MELBOURNE VICTORIA, AUSTRALIA.
TENDERS are HEREBY INVITED for the SUPPLY, DELIVERY, &c., of the following for the Morwell Power Scheme.
Copies of Tender form and specification will be available upon application to—
Agent-General for Victoria,
Melbourne-place, Strand,
London, W.C. 2.
SPECIFICATION No. 24/7.—100,000-Volt TESTING TRANSFORMER.
CHARGE.—10s. for the first two copies of Tender form, conditions of contract and specification complete. This charge will be returned on receipt of a bona fide Tender. A third copy and any further copies will be supplied for the sum of 5s. each. This charge is not returnable.
PRELIMINARY DEPOSIT.—A preliminary deposit of £5 is to be lodged with Tender.
The specifications may be inspected at the above-mentioned office.
The Commission does not bind itself to accept the lowest or any Tender.
Tenders close at the Commission's Office, Melbourne, on the 10th March, 1924, and prices should be cabled (cable address, Electrocom, Melbourne) to the Commission on or before that date, and Tenders on the prescribed form, properly endorsed and addressed, must be forwarded by the following mail to
R. LIDDELOW,
Secretary.
State Electricity Commission of Victoria,
Melbourne, Victoria, Australia. 4949

PUBLIC NOTICES

County Borough of Middlesbrough.
DOCKS, &c., SCHEME.
The Corporation invite TENDERS for the CONSTRUCTION of DOCKS, WHARVES, LANDING-PLACES, &c., at the site of the Ferry, Middlesbrough.
Copies of conditions, specification and form of Tender will be supplied on application to the undersigned, on payment of a deposit of Five Pounds, which will be returned on receipt of a bona fide Tender. The plans may be inspected at the office of Mr. A. C. Mitchell, M. Inst. C.E., Royal Exchange, Middlesbrough, where arrangements may also be made for loan of prints.
Sealed Tenders, on the forms and in the envelopes supplied, are to be delivered to the undersigned on or before first post on Monday, the 24th day of March next, and endorsed "Tender for Docks Scheme."
The Council do not bind themselves to accept the lowest or any Tender.
The scheme will be carried out as work for the relief of unemployment, and the Unemployment Grants Committee's conditions of grant will have to be complied with, which are fully set out in the general conditions.
PRESTON KITCHEN,
Municipal Buildings, Town Clerk.
Middlesbrough,
25th February, 1924. 5089

County Borough of Wolverhampton.
WATERWORKS UNDERTAKING.
15in. AND 12in. CAST IRON TRUNK MAINS.
The Wolverhampton Corporation is prepared to receive TENDERS for PROVIDING and LAYING about 5400 Yards of 15in. and 2950 Yards of 12in. CAST IRON WATER MAINS, and executing other work in connection therewith, from contractors who pay to the whole of their employees such remuneration and observe such hours of employment as are recognised by the Employers' Unions and Associations of Employers in the several localities where the work is done.
A copy of the specification, quantities, and form of Tender, may be obtained from Mr. E. A. B. Woodward, Waterworks Engineer, Town Hall, Wolverhampton, upon payment of the sum of £2 sterling, which amount will be returned to each contractor who submits a bona fide Tender, but not otherwise.
Each Tender must be enclosed in a sealed envelope, addressed to "The Chairman of the Water Committee," and endorsed "Trunk Mains," and delivered at my office on or before 10 a.m. on Saturday, the 15th day of March.
The right to decline the lowest or any Tender is reserved to the Corporation.
F. E. WARBRECK HOWELL,
Town Clerk
Town Hall, Wolverhampton,
5th March, 1924. 5144

Walsall and West Bromwich SCHOOL DISTRICT.
TO BOILERMAKERS, ENGINEERS, BUILDERS, &c.
The Board of Management invite TENDERS for the INSTALLATION of LOW-PRESSURE HEATING and HOT WATER SERVICES at the District Schools, Wigmore, West Bromwich, in accordance with specification and plans prepared by Messrs. Edwards and Shaw, Consulting Engineers, 105, Colmore-row, Birmingham.
Preference will be given to firms on the King's Roll.
Conditions of contract may be seen at the undermentioned address, and specification, plan and form of Tender will be supplied by me upon application being made, accompanied by a deposit of £5 5s., between the 10th and 15th March, 1924. The amount deposited will be returned by cheque after the receipt of a bona fide Tender, sealed and endorsed, "Tender for Heating and Hot Water Services, &c., Wigmore Schools," and forwarded so as to reach me not later than the first post on Friday, the 28th March, 1924.
By Order,
A. H. WARD,
Clerk.
22, Lombard-street, West Bromwich,
1st March, 1924. 5097

PUBLIC NOTICES

Metropolitan Water Board.
TENDERS FOR THE MANUFACTURE, DELIVERY AND FIXING OF TWO 25-KILOWATT STEAM-DRIVEN ELECTRIC GENERATORS, SWITCHBOARD, PIPING, &c., AT LITTLETON PUMPING STATION, MIDDLESEX ;
AND ALSO FOR
ONE 150-KILOWATT STEAM-DRIVEN ELECTRIC GENERATOR, SWITCHBOARD, PIPING, &c., AT WALTON PUMPING STATION, SURREY.
The Metropolitan Water Board invite TENDERS for the MANUFACTURE, DELIVERY and FIXING of TWO 25-Kilowatt Steam-driven ELECTRIC GENERATORS, SWITCHBOARD, PIPING, &c., at their Littleton Pumping Station, Middlesex, and also for ONE 150-Kilowatt Steam-driven ELECTRIC GENERATOR, SWITCHBOARD, PIPING, &c., at their Walton Pumping Station, Surrey.
Forms of Tender, conditions of contract, specification and drawings may be inspected without payment of fee at the offices of the Board (Room 173), Chief Engineer's Department, 173, Rosebery-avenue, Clerkenwell, E.C. 1, on and after Monday, 10th March, 1924.
Contractors desirous of tendering may obtain the necessary documents from Mr. Henry E. Stilgoe, M. Inst. C.E., the Chief Engineer, on production of an official receipt for the sum of One Guinea for either set of documents, which sums must be deposited with the Board's Accountant, and will be returned on receipt of bona fide Tenders, together with all incidental papers. Such payments and applications must be made between the hours of 10 a.m. and 4.30 p.m. (Saturdays, 10 a.m. and 12 noon). Cheques must be made payable to the "Metropolitan Water Board," and not to individuals.
Tenders, enclosed in sealed envelopes, addressed to "The Clerk of the Board, Metropolitan Water Board, 173, Rosebery-avenue, E.C. 1," and respectively endorsed "Tender for Electrical Plant, Littleton" and "Tender for Electrical Plant, Walton," must be delivered at the offices of the Board not later than 10 a.m. on Wednesday, 23rd April, 1924.
The Board do not bind themselves to accept the lowest or any Tender.
G. F. STRINGER,
Clerk of the Board.
Offices of the Board,
173, Rosebery-avenue, E.C. 1,
29th February, 1924. 5117

DREDGER.
The Lee Conservancy Board invite TENDERS, DESIGNS and SPECIFICATIONS for a STEAM LADDER BUCKET DREDGER, 80ft. long by 13ft. beam, depth middle line 4ft. 6in., draught not to exceed 3ft., to dredge to a depth of 12ft., and raise not less than 65 tons per hour, to load into barges 4ft. 6in. above water line, and to be forward cutting to cut its own flotation. The framing and gear to be easily lowered so as to pass under bridges 9ft. 9in. above water line. The hull to be of steel to Lloyd's Specification, with accommodation for two men to sleep on board. State time of delivery afloat ready for work on the Lee Navigation at Bromley Lock, Bow, London, E.
The Board do not bind themselves to accept the lowest or any Tender, and all designs offered are to be at the expense of the persons tendering. Tenders, designs and specifications, giving full particulars, to be delivered in sealed envelopes, marked "Dredger," not later than March 26th, 1924, to—
CHARLES N. TWEEN, M.Inst.C.E.,
Engineer and Manager to the Board.
Enfield Lock, Middlesex. 5126

Torquay Town Council.
WATERWORKS DEPARTMENT.
The Council of the Borough of Torquay is prepared to receive TENDERS for the LAYING and JOINTING of about 4 Miles of 14in. CAST IRON PIPES, SPECIAL CASTINGS and ANCILLARY WORKS.
Specifications and schedules may be obtained on application to the undersigned on payment of a deposit of Two Guineas, which will be returned on receipt of a bona fide Tender.
Sealed Tenders, endorsed "Tender for New Trunk Main—Contract No. 11," together with the specification and schedule of prices, must be delivered to the Town Clerk, at his office, Town Hall, Torquay before Noon on 19th March, 1924.
The Council does not bind itself to accept the lowest or any offer.
SAMUEL C. CHAPMAN, M. Inst. C.E.,
Waterworks Engineer.
Town Hall, Torquay.
29th February, 1924. 5098

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"THE ENGINEER" WANTED.

WANTED, "THE ENGINEER," Bound or Unbound, from July, 1915, to June, 1921.—Address, stating lowest price, P1000, The Engineer Office. P1000

WANTED, "THE ENGINEER," Volumes January to June, 1909, and January to June, 1911 ; Single Copies dated May 17th, 1909 and May 16th and 23rd, 1911.—Address lowest price and particulars to J. D. K. R., The Engineer Office. P1000

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PUBLIC NOTICES (continued)

Tyne Improvement Commission.

DREDGING PLANT.

The Tyne Improvement Commissioners are prepared to receive TENDERS for the CONSTRUCTION and DELIVERY in the Tyne of TWO SINGLE-SCREW STEEL STEAM HOPPER BARGES, each with a hopper capacity of about One Thousand Tons.

Copies of the form of Tender, conditions of contract, specification and outline drawing, may be obtained from this Office on payment of a deposit of £2 2s., which will be returned on receipt of a bona fide Tender.

Tenders, in sealed envelopes, endorsed "Tender for Hopper Barges," must be delivered at the undermentioned Offices, addressed "The Chairman, Dredging and River Works Committee," not later than Noon on Tuesday, the 1st day of April, 1924.

The Commissioners do not bind themselves to accept the lowest or any Tender.

By Order,
ALBERT BLACKLOCK,
Secretary.

Tyne Improvement Commission Offices,
Bewick-street,
Newcastle-upon-Tyne.
5th March, 1924. 5139

Heston and Isleworth Urban

DISTRICT COUNCIL.
ELECTRICITY DEPARTMENT.

FOR SALE, TWO 125 K.W. HIGH-SPEED Davey-Paxman ENGINES, direct coupled D.C. Generators, 480/550 volts, together with Elector Condensers and Spare Armature for each set.

Also FOUR 7in. WATER SLUICE VALVES.

The whole can be viewed by appointment.

Apply to—
ENGINEER and MANAGER.
Electricity Works,
Bridge-road, Hounslow. 5095

Heston and Isleworth Urban

DISTRICT COUNCIL.
ELECTRICITY DEPARTMENT.

Have FOR DISPOSAL, at the Electricity Works, Bridge road, Hounslow, SCRAP COPPER, BRASS, LEAD, CAST IRON and LIGHT IRON. Can be viewed any day at the above address. 5094

SITUATIONS OPEN

ADVERTISERS' BOX 4757, in February 1st Issue. ACKNOWLEDGE APPLICATIONS, with thanks. POSITION NOW FILLED. 5135 A

WANTED, a Thoroughly Competent Theoretical PHYSICIST; must be capable of Independent Research, a brilliant Mathematician, and should know German. Excellent prospects for the right man. State age, experience and salary required, in confidence.—Address, P8776, The Engineer Office. P8776 A

WANTED, in a Large General Engineering Works, PRACTICAL CHEMIST and METALLURGIST. Must have had sound training and be able to give details of actual experience in similar Works, including Analysis of Foundry Metals (Raw Materials and Foundry Cast); also Chemical and Mechanical Tests on Steels of all grades and usual Works supplies, and capable of Interpreting and Advising on Results. Candidates with experience in Micro-photographic Work preferred, but qualifications described above are essential.—Address, with full particulars, age, salary, and experience, 5090, The Engineer Office. 5090 A

ADVERTISING AND PUBLICITY.—A COMPANY, Manufacturing Switch and Control Gear, REQUIRE the SERVICES of a MAN with good Experience in Preparing Press Advertising, Catalogues, and General Publicity.—Write fullest particulars experience, qualifications, and salary required, Box 1044 Sells Advertising Offices, Fleet-street, E.C. 4. 5115 A

CONTINENTAL ENGINEERS REQUIRE JUNIOR ASSISTANT; fully qualified to Inspect and Test Castings and various classes of Materials at Rolling Mills, also Finished Engineering Work, &c. State salary required and previous experience.—Address, P8771, The Engineer Office. P8771 A

ENGINEER WANTED, London, Large Establishment, with thorough Practical Knowledge lighting, Heating, Ventilation, Steam and Electric. Commencing salary, £400 per annum.

State age, qualifications and experience to Box 14,105, Clark's, 57, Mortimer-street, W. 1. 5107 A

OPPORTUNITY OCCURS for the RIGHT MAN, Age 23 to 30, to Assist in the Development of New Electrical Signs. Knowledge of Light, and theory of Small Electric Lighting Installations essential. An investment of £300 is required. Only thoroughly energetic men with good testimonials need apply, as every inquiry will be made.—Address, P8773, The Engineer Office. P8773 A

REPRESENTATIVE REQUIRED by Old-established Firm of Engineers to call on Shipbuilders, Collieries, Engineering Firms, &c., within about 30 miles radius of Durham.—Address, giving particulars, age, qualifications, and remuneration required, &c., 5088, The Engineer Office. 5088 A

SALES REPRESENTATIVE.—WANTED, by One of the largest Commercial Vehicle Manufacturers in the Country, a SALES REPRESENTATIVE for London Area.

The man selected should be an Engineer, and have had wide practical experience in Selling Engineering Products. He should be of good address and capable of meeting, and convincing, the highest business executives.

To such a one, the vacancy offers good remuneration on salary and commission, and good prospects.

Write fully, giving age, full details of experience, and, if possible, enclose copy of a recent photograph. Apply, by letter only, in your own handwriting to: E.J., c/o Thomas Russell, Clun House, Surrey-street, London, W.C. 2. 5114 A

WORKS MANAGER.—ASSISTANT or UNDER-STUDY (Box No. 4976).—ADVERTISERS Desire to generally acknowledge and THANK APPLICANTS for their replies. These are being dealt with as quickly as individual scrutiny of the very large number will permit. Some little time must elapse before even selections for interview can be made. 5109

WANTED by Large Engineering Works in the North of England, ASSISTANT CHIEF DRAUGHTSMAN and DRAUGHTSMEN with thorough theoretical training and extensive experience in the Design and Detail of all classes of Bridges, Dock Machinery (Hydraulic and Electric), Dock Gates, Caissons and Cranes.—Address, with full particulars of training and experience, 5039, The Engineer Office. 5039 A

WANTED, Capable JUNIOR DRAUGHTSMAN, accustomed to High-pressure Hydraulic Work.—Apply, by letter, stating age, experience, and wage required, to THE HYDRAULIC ENGINEERING CO., Ltd., Chester. 5089 A

WANTED, DRAUGHTSMAN, Accustomed to Detailing and Designing of Structural Steel Work, together with Taking Off Quantities, Estimating Weights, &c.—Reply, by letter, stating experience, salary required, &c., to SAMUEL BUTLER and CO., Ltd., Albion Works, Stanningley, nr. Leeds. 5155 A

WANTED, Experienced DRAUGHTSMEN. Must be thoroughly up in all classes of Gas Plants, and of Designing Gasholders, either Guided or Spiral, Purifiers, Condensers, Scrubbers, and Structural Work of all kinds.—Apply, by letter, stating age, salary required, and enclosing references, to 5112, The Engineer Office. 5112 A

WANTED, First-class DRAUGHTSMAN for Electric Crane Manufacturers in Manchester District. Permanency for suitable man. State experience and salary required.—Address, 5108, The Engineer Office. 5108 A

CONSTRUCTION STEEL. — WANTED, a DRAUGHTSMAN, used to Detailing Constructional Steel for Buildings, and who can Make Calculations; should be used to Working to Architects' Plans. State age, experience, and salary required.—Address, P8774, The Engineer Office. P8774 A

THREE IMPORTANT NEW TECHNICAL BOOKS.

(1) PULVERISED FUEL, COLLOIDAL FUEL, FUEL ECONOMY, AND SMOKELESS COMBUSTION.

By L. C. HARVEY, Author of the Fuel Research Board's Special Report No. 1, published for the British Government by H.M. Stationery Office, and entitled "Pulverised Coal Systems in America." Crown 4to, 466 pp., with 260 Illustrations in Line and Half-tone. Price 42s. net.

(2) MECHANICAL ROAD TRANSPORT.

A comprehensive treatise, by a recognised authority, for all interested in the mechanical transport of goods or passengers by road. By C. G. CONRADI, M. Inst. M.E. Demy 8vo, xviii+304 pp., with 180 Illustrations in Line and Half-tone. Price 21s. net.

(3) ENGINEERING STEELS:

AN EXPOSITION OF THE PROPERTIES OF STEEL FOR ENGINEERS AND USERS TO SECURE ECONOMY IN WORKING AND EFFICIENCY OF RESULT.

By LESLIE AITCHISON, D. Met., B.Sc., A.I.C., M.I.A.E., Consulting Metallurgist to the Air Ministry, The Association of Drop Forgers and Stampers, etc. etc. Demy 8vo, 386 pp., 120 Illustrations. 25s. net.

MACDONALD & EVANS, 8, John Street, Bedford Row, London, W.C. 1.

SITUATIONS OPEN (continued)

DRAUGHTSMEN, First-class, for Mechanisms, London district; best men only need apply. Good money for real first-class men.—Address, stating age, salary and experience, 4980, The Engineer Office. 4980 A

DRAUGHTSMAN, for General Plant Work; Large firm in Midlands; age 30-40. Thoroughly experienced men only need apply.—Address, 5148, The Engineer Office. 5148 A

DRAUGHTSMAN REQUIRED; Experienced in Detailing Conveyor and Structural Work; only experienced men need apply. State age, experience, and salary.—Address, 5152, The Engineer Office. 5152 A

DRAUGHTSMEN REQUIRED for Water Tube Boiler Details, London district. State experience, salary, &c.—Address, 5156, The Engineer Office. 5156 A

DRAUGHTSMAN, SENIOR, First-class Man only, for Midlands Electrical Works; experienced with A.C. and D.C. Motors and Generators.—Address, stating age, experience and salary required, 5005, The Engineer Office. 5005 A

DRAUGHTSMAN WANTED (Box 4968 in February 22nd issue).—ADVERTISERS ACKNOWLEDGE with Thanks APPLICATIONS too numerous for reply. POSITION FILLED. 5085 A

DRAUGHTSMAN WANTED AT ONCE, near London; preferably experienced in Air Compressor Work; permanent job. State age, experience and salary required.—Address, 5141, The Engineer Office. 5141 A

FIRST-CLASS DRAUGHTSMAN REQUIRED, West Riding of Yorkshire, able to Design and Carry Out Contracts for all classes of Constructional Steelwork (Building). State age, experience, and salary required. Applications entertained from experienced men only.—Address, 5149, The Engineer Office. 5149 A

REINFORCED CONCRETE.—WANTED, First-class SENIOR DRAUGHTSMAN, thoroughly experienced in Calculations and Working Drawings for Reinforced Concrete Structures of all kinds.—Write, giving full particulars, age, and salary required, to 5110, The Engineer Office. 5110 A

WANTED, FOUNDRY FOREMAN, West of England. High-class Green Sand and Loam Castings, up to 4 tons; also Brass; about 40 moulders. State experience, references, salary, age.—Address, 5111, The Engineer Office. 5111 A

WANTED at an Early Date, WALKING GANGER for reservoir in Yorkshire.—Address, giving all particulars, including age, experience, references, &c., and wages required, 5146, The Engineer Office. 5146 A

SITUATIONS WANTED

WANTED, POSITION AS PUBLICITY MANAGER.

WILL *YOUR* FIRM GET THIS PUBLICITY EXPERT TO MAKE ITS SALES AND PROFITS *LEAP!*

WHY NOT? If your proposition is sound and has a future, your firm will get there quicker and at less cost by having such a man as this on its staff.

He is 32 years old, and known as a strong young man, a live wire, and straight. He is an organiser with capacity to get things done, is full of brilliant ideas and energy, and has been Publicity Manager of more than one engineering firm of world-wide repute, turning out sales-creating advertisements, catalogues, booklets, leaflets, articles, running circularising campaigns, exhibitions, &c.; careful buyer of space and printed matter.

Will you see him and his first-class references? Write, P8785, The Engineer Office. P8785 B

A M.I.C.E. (33), Railway Locomotive Works and D.O., charge of loco. steam sheds, automobile and varied general engineering experience, used to control of large staffs, DESIRES POST.—Address, P8790, The Engineer Office. P8790 B

A M.I.C.E. (33), 5 Years' High-class Machine Shop and jig and tool D.O. experience, 5 years' war service, 4 years lay-out and erection of plant and conveyor gear, design of machinery, &c., SEEKS POST with prospects; excellent refs.—L., 277, Northfield-avenue, S. Ealing, W. 5. P8784 B

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ENGINEER (22) DESIRES POST as Junior Draughtsman, 2½ years' shop experience, 3 years' D.O.; good reference.—Address, P8781, The Engineer Office. P8781 B

SITUATIONS WANTED (continued)

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ENGINEER MILLWRIGHT (Experience), Erection, maintenance of engines, boilers, machinery, shafting, motors, pumps, &c., could keep buildings in repair if required, SEEKS SITUATION.—Address, P8801, The Engineer Office. P8801 B

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SITUATIONS WANTED (continued)

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YOUNG MAN (27), with Organising Ability and thirteen years' machine shop experience, SEEKS SITUATION as Machine Shop Foreman, or progressive position.—Address, P8796, The Engineer Office. P8796 B

DRAUGHTSMAN (22) REQUIRES POST; 4½ years' automobile and 2 years general engineering experience; good mathematician; excellent references.—C. BAILY, 3, Market-place, Reading. P8789 B

WORKS DRAUGHTSMAN, Constructional and mechanical, REQUIRES POSITION. Colliery equipment, screening, washing, haulages; 4 years' D.O., good tech. educ., refs.; age 27.—Address, P8793, The Engineer Office. P8793 B

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For continuation of Small Advertisements see page 3.

A Seven-Day Journal

St. Paul's Bridge.

A CONFERENCE of representatives of the Royal Institute of British Architects, the Town Planning Institute, the London Society and the Architecture Club, has addressed a letter to the Prime Minister expressing the concern felt by these four societies on the subject of the proposed bridge across the Thames in the neighbourhood of St. Paul's Cathedral. The signatories protested against the expenditure of public or other funds on the scheme, principally because they held it to be conceived without sufficient breadth of outlook. The bridge, if constructed, would, they held, be a costly blunder, and would be likely to add to rather than diminish the difficulties of the London traffic problem. Its utility would be unimportant, for it would be within 300 yards of Southwark Bridge, which, even now, was but little used. They urged that a complete and comprehensive plan for the re-arrangement of London's traffic ways should be taken in hand, and that London's great size, far from being an excuse for piecemeal changes, rendered such changes inexcusable. The signatories did not mention the alternative proposal for a new road bridge at Charing Cross, but some, at least, of them are known by their previous pronouncements to be strongly in favour of that grandiose scheme.

The L.C.C. and Applied Science Fellowships

DURING the war the London technical institutions, as a contribution towards the production of munitions, undertook the training of workers and the manufacture of gauges. After all charges have been met, the sums received for such work have left a residue of about £32,000 in the Council's hands. Deducting prospective grants for equipment, &c., at certain of the institutions, there now remains a residue of £20,000. It has been decided by the Education Committee to recommend the Council that this remainder should be devoted to the establishment of two fellowships, each of an annual value of £450. The fellowships would be awarded in connection with applied science and technology, with preference given to engineering science, and would be tenable in the Dominions, the United States, or other foreign countries. Candidates would be selected by the Education Committee after consultation with the Consultative Committee on Engineering, and preference would be given to those who had completed courses of study in London institutions, or who had been identified with the London teaching service. The fellowships would be known as the "Robert Blair Fellowships for Applied Science and Technology," and would be awarded annually in July. Candidates, being British subjects of not less than twenty-one years of age, would be required to submit particulars of their training and of the scheme of advanced study and research which they proposed to undertake during their tenure of the fellowships.

Retirement of Sir Arthur Watson.

IT is with much regret that we have to announce the resignation of Sir Arthur Watson, the general manager of the London, Midland and Scottish Railway. Sir Arthur began his railway career as an engineer of new works on the Lancashire and Yorkshire Railway, and, when only about thirty years of age, became its assistant engineer. Sir John Aspinall was then the general manager, and, later, created a departure by appointing the assistant engineer to succeed the superintendent of the line. When Sir John's retirement was imminent, the position of assistant general manager was added to the latter office, and eventually Sir Arthur—then Mr. —Watson succeeded Sir John as general manager. Three years later—on January 1st, 1922—when the London and North-Western and the Lancashire and Yorkshire were amalgamated, he was made general manager of the combined system and then filled the same office for the London, Midland and Scottish when it was constituted at the beginning of last year. The task of forming and consolidating that huge concern—which has a capital of nearly 400 million pounds and employs 269,000 persons—has put too great a strain on Sir Arthur's strength and his health has broken down. He will be succeeded in the general managership by Mr. H. G. Burgess, who was appointed deputy general manager as recently as last December.

Grit Experiments at Birmingham.

ONE of the difficulties associated with the operation of large power stations is that of preventing the emission of fine grit from the chimneys. For a long time past experiments have been carried out at the Nechells station of the Birmingham Corporation, and it is believed that the trouble has now been overcome. The latest experiments have been in the direction of washing the flue gases before they are passed into the chimney, and the quantity of grit that has been trapped in this way has been found to be far in excess of that obtained by other methods. Various types of washers are now being tried, and when the most satisfactory arrangement has been selected it is proposed to equip all the chimneys in the same way. The emission of grit from the chimneys of large power stations is a very common form of nuisance, and in carrying out these experiments the Birmingham engineers have rendered very useful service.

Imperial Wireless Communication.

THE report of the Imperial Wireless Telegraphy Committee, 1924, which was appointed to advise on the policy to be adopted in connection with Imperial service, recommends that the State should own all the wireless stations in Great Britain for communication with the overseas Dominions and that the Post Office should operate through an improved business organisation all the Empire stations in Great Britain. It is suggested, however, that an exception should be made in the case of Canada, and that, subject to certain conditions, competition between the Post Office and private enterprise in the Anglo-Canadian service should be continued. If any licence be granted to a private company, the State will reserve the right to take possession, or exercise control over the working, of the licensed stations when, in the opinion of the Government, an emergency arises which requires it. It is also recommended that the Leafield station should be enlarged, that the new high-power station in the course of construction at Rugby should be extended, and that a second new station of similar capacity should be erected as soon as possible.

Road Building Schemes.

DURING the past week contracts have been completed for the construction of several new roads in the Home Counties, which will involve a total expenditure of nearly a million and a half sterling. These schemes comprise the first 6 miles of the new Watford by-pass, which, by avoiding the local traffic of Hendon, Edgware and Watford, will expedite transport on the Great North Road. This section is to be built by Sir Robert McAlpine and Sons, and will be 100ft. wide. The Orpington by-pass road, for connecting the Maidstone and Sevenoaks roads, is to be put in hand by Sir W. G. Armstrong, Whitworth and Co., who are to construct 6½ miles of 80ft. wide road. Another length of 6 miles for connecting the Shooter's Hill and Dartford by-passes, also 80ft. wide, is to be laid out by Sir Wm. Arrol and Co., while a road from West Wickham to Farnborough is also to be begun.

Thurrock, Grays and Tilbury Sewerage.

ON Saturday last Mr. A. Brennan, the chairman of the Thurrock, Grays and Tilbury Joint Sewerage Board, formally opened the new drainage and sewage disposal works, which have recently been completed for that body. The works, which were designed with a view of ultimately serving a population of some 66,000, comprise an intercepting sewer about 7 miles long, and varying in diameter from 15in. to 36in., main and subsidiary pumping stations, precipitation and storm water tanks, percolating filters, sludge and humus beds, &c. They are noteworthy in several respects, and not the least because of the extraordinarily difficult nature of the ground through which parts of the sewer were run, and of that of the site on which the disposal works had to be built. Nearly the whole length of the sewer was constructed through marshes, in which the subsoil consists of peat and a semi-fluid clay. So fluid, in fact, was the soil that in places, after reaching a depth of some 15ft., the bottoms of the trenches were forced upwards by the weight of soil on either side, and timber decking had to be provided to withstand the upward pressure. The same sort of trouble was met with when building the tanks and pumping station, and unusual expedients had to be employed during construction. In spite of all obstacles, however, the works were completed in an eminently satisfactory manner, and they have a most workmanlike appearance.

A Converted Steamship's Performance.

SOME interesting figures are now available concerning the performance of the motor ship Seekonk, which was purchased from the United States Shipping Board as a Hog Island A Class steamship, and converted into a motor ship by the William Cramp and Sons Ship and Engine Building Company, of Philadelphia. She was originally a 400ft. vessel, of 11,400 tons displacement, with geared turbines and oil-fired boilers. The steam machinery and auxiliaries were taken out, and were replaced by a single-screw Cramp marine oil engine, of the Burmeister and Wain long-stroke type. This engine was designed to develop 2300 indicated horse-power, when running at a speed of 85 to 90 revolutions per minute, and has six cylinders, each 29in. in diameter and a stroke of 59in. Its installation increased the cargo capacity of the ship by 1000 tons, and her cruising radius by three times. On arriving in New York recently, the Seekonk completed a run of 13,329 miles on the intercoastal service of the United States Lines. During the voyage, 50 days and 20 hours were spent at sea, 4 days and 14 hours in rivers and harbours, and 28 days and 8 hours in ports. The oil fuel consumed at sea was 7.52 tons per day, and 0.7 ton when in port. An average sea speed of 10.29 knots was made. Comparing these results with the performance of a similar steamship, the Hog Island, one of the best of its class, the fuel consumption of the motor ship is shown to be only about one-fourth that of the steamship. In five voyages, the Hog Island maintained an average sea speed of 10.02 knots, consuming 29 tons of oil fuel per day at sea and 7.5 tons in port. The Seekonk is one of more than 100 similar vessels built by the Shipping Board during the war.

Increased Costs in the Iron Trade.

IN the course of the speeches made at the annual dinner of the South Staffordshire Iron and Steel Institute, which was held at Dudley on March 1st, Colonel J. S. Trinham, of N. Hingley and Son, made some comparisons between the costs of iron and steel manufacture in pre-war days and in the present time. Wages, he said, had advanced 98 per cent. per ton of output. Improved practice had brought about a reduction in the consumption of fuel per ton of output of 8 per cent.; but, notwithstanding this, the fuel bill had advanced per ton of output by 60 per cent. There had also been the following average increases per ton of output:—Workmen's compensation insurance contributions from 2.2d. to 4.2d., or 90 per cent.; National Health Insurance contributions from 3d. to 1s. 9d., or 600 per cent.; poor and general district rates from 3.8d. to 7.7d., or 108 per cent.; income tax, Schedule A or property tax, from ½d. to 2.6d., or 400 per cent.

The Southampton Crisis.

ON Saturday last the shipyard workers at Southampton decided to continue their strike for a local advance of 17s. 6d. per week, in order to bring the wages paid at Southampton into line with those obtaining at the Port of London. The Federation of Engineering and Shipbuilding Trades has pointed out to the strikers that their action constitutes a breach of the procedure for the settlement of disputes in industry, and the Shipbuilding Employers' Federation is meeting to consider the position created. As the men at Southampton are covered by the national application of shipyard workers for an advance of 10s. per week, which advance will be considered at a forthcoming conference, a difficult position is created, and efforts are being made by the men's national Federation to secure resumption of work at Southampton, so that the larger issue can be dealt with. At the present time there are several important liners undergoing repairs and reconditioning at Southampton, including the Cunarder Mauretania, which is in the hands of John I. Thornycroft and Co., Limited, and the White Star liner Majestic, which is laid up for annual overhaul. The North Atlantic traffic is expected to be particularly heavy this year, and if work is not resumed at an early date, serious delay cannot be avoided. The sailing of the Mauretania, fixed for March 29th, has, in fact, already been cancelled. The only men working in the port are the members of the Shipwrights' Society and the Boilermakers' Society.

Profit Sharing in an Engineering Works.

WITH the object of giving all its staff and workpeople a chance of participating in the prosperity of the company, and at the same time of creating a greater interest in their work, Royles Limited, of Irlam, some years ago introduced a profit-sharing scheme, which has given great satisfaction to all concerned. Under the scheme a distribution has recently been made, amounting to 8 per cent. on the salaries and wages earned during 1923. The scheme embraces several features which are worthy of notice. For instance, in the case of sickness of more than three days' duration, no deduction from the bonus is made if the sickness has not been caused by misconduct on the part of the person concerned. Again, if a person is discharged by the firm as a result of shortage of work or any other reason which is no fault of his or her own, the employee is entitled to receive a bonus calculated up to the date of leaving. Further, the firm pays wages in full to its workpeople for seven days' summer holidays.

A Canal-Road Scheme.

SEVERAL proposals have in the past been made for the conversion of our canals into roads for the use of high-speed motor traffic. The latest one to be discussed aims at such a conversion of the Regent's Canal for a length of 8½ miles, whereby the London dock area would be linked up with various railway goods yards as far as Paddington. The Canal has an average width of 60ft., and it is proposed to divide the suggested road into two 20ft. ways at the centre for fast up and down traffic, with a 10ft. width on each side for vehicles loading and unloading. Apart from the cost of purchasing the Canal, the work of conversion is estimated to cost something under three million pounds, and to provide scope for the employment of 6000 men for a year. It is contended that the Canal at present is of relatively little value, but that converted to a road, it would help greatly to relieve the congestion of traffic in the London area.

Estimating.

By an A.C.G.I., Assoc. M. Inst. C.E., M.I. Mech. E.

THE success or failure of an engineering concern is, to a very great extent, contingent upon the satisfactory functioning of the estimating department, and yet, very often, the work is entrusted to men who cannot, by any stretch of the imagination, be termed trained engineers.

The path of the estimator is a thorny one, for, on the one hand, he knows full well that if he gives a very close estimate on the assumption that everyone will do the part allotted to him without failure, a loss to the company will result, whereas, on the other hand, if he prepares a really safe estimate, more likely than not no business will result. It is in the determination of that *via media* that much of the skill of the estimator lies.

It is the intention, in this article, to deal with the requirements of a factory employing, say, 5000 hands, and manufacturing more than one type of product. The subject can readily be resolved into the following components:—

(1) The *personnel* of the department.
(2) The preparation of the estimate.
(3) Co-ordination of effort.

(1) Personnel.

The staff employed must, to a certain extent, be dependent upon the general organisation of the factory; but it is essential that the work should be concentrated, and that all estimates should be passed for approval to a chief estimating engineer who will report direct to the general manager and will have the opportunity of criticising all estimates prepared for the respective manufactures. If the factory is divided into a number of separate departments, each dealing with its own specialised product, there should be a departmental estimator for each such department, under him being the actual estimators, the number of whom will, naturally, depend upon the nature and volume of the work.

It has been found in practice that the estimators may, with advantage, be subdivided, a certain proportion being technical men, and the remainder clerical. This implies a definite division of work, but there is so much that is of a purely routine nature, only involving a general mathematical knowledge, that it would not be economical for a technical man to be employed on such work. It is, however, only asking for trouble to expect clerks, although they may have acquired a certain degree of practical experience, to take out quantities for complicated mechanisms.

As an experiment, the two sides have been paired together with very satisfactory results, the technical estimator doing all the investigation that calls for engineering knowledge, and calculating material requirements, and then passing it to the estimating clerk, who casts the figures and finishes the build up. After a while, an intelligent clerk will be able to tackle a simple estimate in its entirety; but even then it is advisable for the technical estimator to glance through it before submission to the departmental estimator.

The most suitable recruiting ground for technical estimators is a debatable point, some contending that draughtsmen of a certain mentality are the best fitted to the work, while others advocate selection from among the most proficient ratefixers. There is much to be said for both points of view, but it is felt that the ideal man is the ratefixer who has had considerable drawing-office experience. Of however high a standard his actual technical attainments, he will probably be a failure unless he is also gifted with tact, judgment and breadth of vision. If this be true of the estimator, how much more so is it necessary in the case of his chief, who will have to confer with departmental managers and responsible officials in the drawing-office, ratefixing and other establishments. It will sometimes be felt that he is trespassing in the natural preserves of others, and it will only be by the application of consummate tact and diplomacy that he will be able to gain all the information he requires without making himself a burden to others. It is for this reason that college-trained men have been selected by some concerns for these posts, and with excellent results. It is not so much that his theoretical knowledge is of primary importance, valuable though it assuredly is, but it is rather the training in the College Union, the possession of a developed mentality, and a logical faculty that prove of such value in a post calling for special personal qualifications.

Pride of place has been given in this article to the *personnel* of the department, as it is the firm conviction of the author that, however perfect the scheme may be, it is foredoomed to failure if it is not put in the hands of efficient men.

(2) The Estimate Itself.

In order fully to appreciate the method of preparing an estimate, which it is the author's desire to describe, it will probably be advisable to follow the fortunes of the estimate from the time it reaches the general office until it has been completed and consigned to the post for good or ill.

Assuming that instructions have been given that all inquiries and letters concerning quotations shall be given priority, as in most cases a definite time limit is imposed, an inquiry will be in the hands of the estimating department early in the morning. It will immediately be given a reference number, by which it will henceforth be known and by which it will be linked up with the order if the tender is successful.

Estimates may be divided into two classes: (*a*) for work that is of a repeat nature, and (*b*) for an entirely new product. In the first case, there is usually little difficulty in quoting, but as there must have been a time in the past when each job was a new one from the estimator's point of view, it will be more simple to consider the new product first, and then briefly suggest the procedure to be adopted in the case of a repeat estimate.

The department in which the work would be done is first decided, this usually being a simple matter as the lines of demarcation are clearly defined; the inquiry is then passed to the drawing-office for the preparation of a "Bill of Materials," which may almost be called the backbone of the estimate—Fig. 1. The drawing-office will detail all the drawings required, the nature of the material, the net weight of the finished component, and having completed columns 1 to 6, will return, duly certified, to the estimating department, for it to determine the necessary allowances for machining, casting, forgings, &c., and to complete the Bill of Materials. Concurrently with this, the inquiry will be in the hands of the ratefixer, who will be responsible for determining the wages that will be required to satisfy the factory.

BILL OF MATERIALS.

Est. No......
General Description..... *Sheet No.*.....
Drawing Nos...... *Specification Nos.*..... *Date*.....

Detail No.	Description of Part.	No. to a Set.	Material.	Purchase Specn.	Estimated Finished Weight or Size (per one).	Gross Weight.	Actual Weight (from factory).	Total Material Required (per one).

(*Signed*)..... (*Signed*).....
Draughtsman. *Estimator.*
Date..... *Date*.....

FIG. 1—THE BILL OF MATERIALS

In the absence of a separately constituted planning branch, the planning can be conveniently done at this stage by means of a conference with representatives of the ratefixers, the shop management, the drawing-office, and any others concerned, for not only is it necessary to determine the method of manufacture before piecework prices can be assigned, but a delivery promise is nearly always also necessary, and this can only be arrived at in a satisfactory manner by the study of existing commitments, as evidenced by shop load diagrams, or whatever other means are employed to reveal the situation. Schemes of this nature being outside the scope of the present article cannot be described, but it must be emphasised that the success of the estimating department is, to a considerable extent, influenced by the functioning of the production department.

Obviously the estimator cannot go very far with his estimate until methods are determined: it would be futile for him to be busying himself working up an estimate which assumed castings when the ratefixer was considering forgings, and the only satisfactory solution is for the ratefixer and estimator to keep in the closest touch all the time. In order to facilitate this contact, ratefixers and estimators are sometimes found in the same office; but what is gained by this co-ordination is more than counterbalanced by the serious loss that is encountered by having ratefixers in the general office, and not in the shops where they are in daily, hourly contact with the problems connected with their work, and are readily accessible, so that the shop foreman can confer with them whenever occasions arise. To maintain that *liaison* that is so essential the departmental ratefixer can be stationed in the general office, and, if possible, in the same room as the departmental estimator.

When the complete lay-out of the job has been determined, the ratefixer will assign his prices for the various operations and, when he has obtained the concurrence of the shop organisation, the wages are calculated and entered up on the ratefixer's schedule—Fig. 2—the bonuses being shown separately, so that the schedule can be readily applied for a future estimate even though the bonus has altered in the interval.

The estimator is now in a position seriously to tackle the whole estimate, having in his possession the bill of materials, coupled with the ratefixer's schedule, which furnishes the necessary particulars regarding proposed operations.

Fig. 3 shows the form on which the complete estimate is prepared, each individual item being subdivided into material, wages, and factory overhead.

The bill of materials is completed by the estimator who has the drawings before him, and with his knowledge as to the way in which it is proposed to complete the work is able to add the necessary percentages for machining, defective, &c., and finally to state the amount of material actually required for manufacture. The bill of materials will be filed away, and, in the event of an order resulting, materials will be obtained in conformity with it, and nothing in excess of its provision will be allowed except after complete investigation. Consequently the bill will be an excellent check to see that the estimate is not being exceeded. When the work has been actually manufactured it is weighed so that actual weights can be inserted, and any discrepancy between the actual and estimated can be examined and adjusted for future quotations. The cost of materials is not shown until we come to the estimate sheet proper—Fig. 3. Having obtained the total amount required, the rate chargeable is obtained from the stores branch if in stock, whereas if it has to be purchased a rate is quoted, due allowance being made for anticipated fluctuations of the market.

In order to obtain as much relief as possible, a special column is furnished for credits, which may be obtained from the sale or melting of scrap, metal shavings, &c., and the net cost of material determined.

The statistics furnished by the ratefixer enable the wages columns to be completed, it being usual to adopt prearranged symbols to indicate the different operations.

RATEFIXER'S SHOP SCHEDULE.

Est. No......
Date Commenced..... *Nature of Store*..... *Ref. No.*.....
Date Completed..... *Works Number*.....

Description.	Material.	Operation.	No. Required.	No. to a Set.	Drawing No.	Total Man Hours	Total net Wages. £ s. d.	Bonus. 18½% £ s. d.	Bonus. Pence Payment £ s. d.	Total Wages. £ s. d.	Shop Centre No.	Machine Group. No.	Remarks.

(*Signed*).....
Ratefixer.

FIG. 2—THE RATEFIXER'S SCHEDULE

Before finishing with the main part of the table, a few words are necessary on the process of levying the "factory overhead." This levy may be accomplished in a number of different ways, of which the crudest is to have a predetermined percentage levied on the wages represented irrespective of the shops in which the work is performed, but so fixed that when applied to all the factory products, the sum obtained in the year will balance the amount required, realising that a percentage which would lead to a big over absorption might jeopardise business, while a serious under absorption would land the company in financial difficulties.

The only virtue of this system is its simplicity of application. A job that costs £50 in wages and £10 in material, will, if the factory overhead is 110 per cent., have a total manufacturing cost of £50 + £10 + 110 per cent. of £50, or £115 in all.

But by this method small and large work will bear the same ratio of overheads, and though this may

be good for the big work, it may drive the company to abstain from doing business in small work, saddled as it is with its share of the cost of big buildings, powerful travellers, large and expensive machine tools, &c. The unfairness of this system led to a compromise, viz., the adoption of a separate percentage for a number of different sections, and this in turn gave place to the machine hour-rate method, the soundest of them all, and one that is fast finding favour with cost accountants.

It is this system that is called for in connection with the estimating described in this article, but a discussion on it would lead into the realms of cost accounting, and it must suffice merely to state that every machine tool is rated at so much an hour, and each job is charged with "factory overhead" to the number of hours spent by the different machines on the manufacture of the article. These rates can be varied from time to time to suit the varying conditions that obtain, but it is obvious that the more stable they are, the more satisfactory it will be, both from the point of view of estimating and that of manufacture.

For the sake of convenience machines of the same size and type can be grouped together and given a common rate. The man-hours having been arrived at when the wages were being determined, it is an easy matter for the clerk to obtain the necessary factory overhead for each article. The machines or machine groups will have been classified under each shop (which will be known by its shop centre number).

If, for example, the operation is turning and the work is to be done in the heavy turnery, the estimating clerk will refer to his rate schedule for that shop centre, consult the machine group in which the work will be put, and beside the group number will be found the rate.

Assuming the rate proves to be 2s. 3d. and the man-hours column gives 10, then the amount chargeable for factory overhead will be £1 2s. 6d. By treating each item similary the complete charges for factory overhead rates will be obtained. Factory overhead rates will, of course, also be applied in the case of fitting and other operations which do not involve machine tools, the only difference being that in arriving at the rates there will not be charges to cover maintenance of machinery, cost of power, &c., except in so far as travelling cranes, &c., are concerned. In fact, each shop centre is treated on its merits, and each operation also on its particular merits.

A good estimator will not, of necessity, slavishly follow the rates quoted by the cost accountant. For example, he may realise that a really large order might involve the employment of additional hands, which might have the effect of materially lowering the factory overhead of the centre concerned, in which case he would be fully justified in using a proportionately lower rate. It is advisable, however, that before doing so the concurrence of the chief estimating engineer be obtained.

A correct application of the rate for estimating purposes can only come as a result of experience, coupled with a general knowledge of factory conditions. When the details have been worked out in the manner indicated, the estimator is in a position to prepare the final summing up of his estimate.

From previous records of work of a somewhat similar nature, and the closeness with which the actual expenditure was in agreement with the estimate on that occasion, he will judge what percentage should be added as a reasonable amount to cover unforeseen contingencies. This should not be a large amount, and is entirely distinct from the allowance for defective parts, and the factor of safety allowed on wages by the ratefixer, as these have already been included on the detail sheet. It should also be remembered that there is an additional safety factor in the wages, represented by the difference between the normal piecework earnings, and the ordinary daywork rate of the operator; in other words, if the job takes longer to perform than was anticipated, the company will not be at a loss as regards wages until the time limit has been exceeded to such an extent that piecework earnings fall below guaranteed daywork. The fact that overhead charges would be increased on account of the additional hours worked, must not, however, be ignored. Many orders have been lost by a lack of knowledge of the foregoing points, which led to the use of too high a contingency factor. Again, estimates have been badly exceeded by an inadequate allowance having been made for initial expenditure, the principal items of which are drawing-office charges, the cost of jigs, tools and gauges, patternmaking, &c. In the majority of cases, these classes of work are performed by daywork, and, consequently, have an unfortunate way of mounting up, unless a very close watch is kept on them, and the factory is fully aware of the respective allowances made for them in the estimate.

On account of the difficulties experienced in giving a close estimate from the somewhat meagre information available at the time of tendering, some factories have decided to treat these initial expenses as indirect, and so part of the factory overhead charges; but while, in very exceptional cases, this may be advisable, it is felt that the logical way is for the job itself to pay for its own initial expenses. These, accordingly, must be estimated, but it is most essential that the management shall have an opportunity of seeing and agreeing to this item before it is embodied in the estimate.

Before finally closing the estimate, the estimator will carefully check it over, peruse the conditions and general specifications, and satisfy himself that nothing has been omitted. The promise for delivery should be made concurrently with the estimate, and a convenient way is for individual promises to be inserted in the ratefixer's schedule, obtained from the foreman while the ratefixer is getting out his part. All the respective promises so made are then co-ordinated in the office, the limiting factors determined, and a reasonable and safe promise deduced. Before the completed estimate is presented

COMPLETE DETAIL OF ESTIMATE.

Date..... *Description*..... *Per*.....*Reference No*..... *Spec. No*..... *Est. No*.....
Works Order..... *Rate Fixing Sub. No*.....

Detail of Materials.						Credits.* Cuttings or Scrap.			Detail of Wages.								Factory Overhead.		
Article or Components and Description of Material.	Drawing No.	Quantity.	Rate.	Per.	Value.	Quantity.	Rate.	Scrap Value.	Material Net.	Operation.	No. Reqd.	No. to Set.	Man Hours.	Man Hours + Def. %	Wages Net.	18½%	Pence Payment.	Total Wages	Total Wages + Def. %	Centre No.	Group No.	Rate Per Hour.	Factory Overhead Amount.	Remarks
			£ s. d.		£ s. d.		£ s. d.	£ s. d.	£ s. d.						£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.			s. d.	£ s. d.	
								Material Summary	£ s. d.						Wages Summary			£ s. d.		Factory Overhead Summary		£ s. d.	

* Figures in these columns to be inserted in red ink.

Delivery.....

Commencement of Delivery.....

Rate of Delivery.....

INITIAL EXPENSES.

	£ s. d.
Special Tools	
Patterns	
Drawing-office Expenses	
Total	

	£ s. d.
Materials	
Wages	
Factory Overhead ..	
Contingencies, % ..	
Painting and Packing	
Initial Expenses ..	
Grand Total ..	

FIG. 3—THE ESTIMATE DETAIL SHEET

COMPARISON BETWEEN ESTIMATE AND ACTUAL COSTS.

Department..... *Shop Centre No*..... *Date*..... *Sheet No*.....

Works Order No.	Sub. No.	Description.	No.	Estimate. Material.	Wages.	Factory Overhead.	Total.	Actual. Material.	Wages.	Factory Overhead.	Total.	Remarks.
		Total ..										

(*Signed*).....

FIG. 4—COMPARISON OF COSTS

Estimate Number:— Description:

Prospective Customer:.....

Date inquiry received:..... Date for return:..... Date of return:.....

Departments concerned:.....

QUOTATION SUMMARY (*Detailed on Reverse*).

	Our Tender.	Actual Price.	If Tender is Lost give Successful Quotation.
Price			
Time for completion			
„ „ commencement			
Rate of delivery			
Price quoted per			

Notes as to special requirements (jigs, drawings, &c.).....

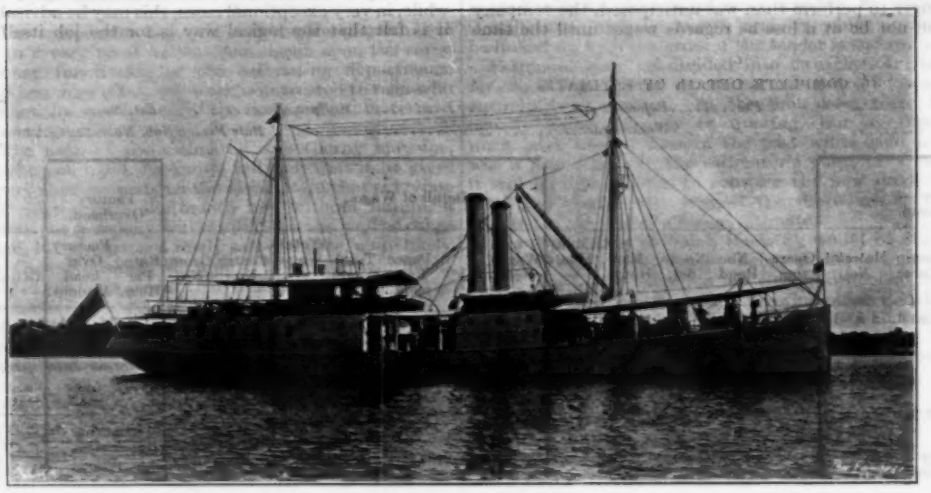
Previous quotations for similar articles.....

If order is obtained, any modification to price or time?.....

FIG. 5—CARD SUMMARY

THE TWIN-SCREW MOTOR YACHT SEA KING

THE NOVA SCOTIA STEEL AND COAL COMPANY, LTD., NEW GLASGOW, BUILDERS



to the chief estimating engineer, it should be submitted to the works management, which will approve it from the manufacturing point of view. This, it is considered, forms a very valuable link in the chain, and in practice is not found to impose undue responsibility on those whose primary function is to "produce the goods."

The estimate so prepared will represent the sum for which the work should be completed, and will include everything except the allowance for profit—unless, as is sometimes the case, it is found desirable to have a separate item for the organisation of a separate London office.

The selling price should be no concern of the estimating department, for it is frequently a matter of policy, and in launching a new product it may be decided to eliminate profits, or even to sell below cost price.

In dealing with quotations for articles that have been already manufactured by the company, the procedure is a simple one. In the first case, it is verified that the work has been done before at estimated cost, and if not the circumstances responsible for the variation are considered. There is a Bill of Materials already in existence, as well as a ratefixer's schedule and a detail of the estimate. Having determined that, in the light of experience, no cheapening of methods can be introduced, the current estimating hourly rates are used, present prices for materials obtained, and the new estimate is soon completed.

(3) Co-ordination.

If the estimating department is to work satisfactorily, there must be the heartiest co-operation between it and the cost accountant and also the workshop.

The build-up of the estimate should show the amounts allowed for the different component parts, and the work should be costed in a similar way, so that on its completion the estimated and the actual cost can be clearly shown side by side for comparative purposes. A good estimator will learn much from an intelligent and careful investigation of the figures furnished by the accountant, and he should make sure that he always gets a copy of them. A convenient form of making this return is shown in Fig. 4. The works manager should also have particulars of the detail of the estimate, so that he can keep a watchful eye on his expenditure week by week, and do all within his power to keep well within the estimate, and, if needs be, resort to special measures to save the situation before it is too late.

Too often it is assumed that when the cost of work is found to exceed the estimated figure, it is the estimate that is wrong, whereas a thorough investigation would reveal a lamentable failing on the part of the works. Consequently, it is advisable to hold a sort of "inquest" every month on some of the worst cases, and here the cost accountant helps by furnishing a complete detail of expenditure, which is compared with the detail sheets of the estimator, and the point of divergence determined. It should now be an easy matter to settle where the blame lies, and if the estimator is at fault he will see that the estimate is duly corrected so that the error is not perpetuated, while, if the mistake lies at the door of the factory, the manager will bring it to the notice of the foreman concerned so that suitable action may be taken. These "inquests" may often involve a good deal of time and work, but they are well worth it, for they serve a very useful purpose in keeping all the parties concerned alive to their responsibilities, and they also serve to avert blame from being laid upon someone whose own part has been correctly performed.

It may often be desirable to refer to an estimate without consulting the detail sheets, and for this purpose a card index has been found very suitable, and on it much information can be co-ordinated. A separate card is used for each quotation, and only the salient points are included. Fig. 5 shows a card that has been in use for some time and has been found to serve the purpose. The card in itself is quite self-explanatory. The more completely it is filled up, the more useful it will be, but it will, naturally, often be found impossible to ascertain what the successful quotation of a competitor was, although it is most useful to record it when it comes to the knowledge of the estimator.

It will be found necessary to have several other forms for minor services, but as these will probably require modification to suit the needs of the individual factory, it is hardly advisable to discuss them in a general article of this nature, which has aimed at giving an outline of a system that has actually been put into operation with very gratifying results.

The Twin-screw Motor Yacht Sea King.

A PRIVATE yacht usually presents features of interest because it nearly always embodies the owner's ideas with regard to lay-out of hull and propelling machinery. In the case of the Sea King, a twin-screw motor yacht and exploring vessel, built for the Baron Bliss, this is more than usually true, since the owner not only designed the vessel and the machinery lay-out, but he also prepared and supervised the carrying out of the designs for the interior decoration, and of the whole of the furniture and fittings, even down to such minute details as the skylight screw quadrants. There is an admirable note of simplicity throughout the rooms which is well illustrated in the accompanying engravings and those which we reproduce on page 256.

The Sea King, illustrated above, is the sixth large yacht designed by the owner, and the following are her principal dimensions and particulars:—

Length, overall	147ft. 9in.
Length between perpendiculars	137ft. 10in.
Moulded breadth	28ft. 6in.
Moulded depth	10ft. 8in.
Draught	7ft. 6in. to 6ft. 6in.

Propelling Machinery.

Twin Vickers-Petters hot-bulb engines, total	440 B.H.P.
Number of cylinders per engine	4
Diameter of cylinders	14in.
Piston stroke	16in.
Speed of engines	275 R.P.M.

Tank Capacities.

Fuel oil deep tanks combined	30 tons
Deep ballast tank amidships	34 tons
Deep fresh-water tank amidships	68 tons
Fore peak ballast tank	18 tons
Aft peak ballast tank	6 tons

Before describing the vessel, the lines and construction of which are illustrated in to-day's Supplement, some of the special features of the design may be noted. In many large yachts the plan adopted when fixing the crew accommodation is to place the seamen forward and the officers and stewards aft, with a galley and pantry about amidships, generally next to the dining saloon. Such an arrangement means a constant traffic of servants or crew up and down the decks, with cooks and servants continually moving in and out of a galley adjoining the owner's private apartments, making quietness and privacy impossible. Where the owner lives on board all the year round, the many disadvantages of such a plan are manifest.

In the Sea King, it will be observed, the accommodation for the crew and officers is placed forward and it includes a large galley, 16ft. by 8ft. 6in., and a pantry on the main deck isolated from the owner's deck-house. It has the further advantage that the members of the crew have the fore-deck to themselves, and the deck structures referred to form a shelter in the neighbourhood of the accommodation ladder. This arrangement has proved most comfortable in practice, although, perhaps, it does not improve the appearance of the ship.

FIG. 1—OWNER'S WORKSHOP IN THE SEA KING

The Hull and Accommodation Arrangements.

The contract for this yacht was placed in Canada with the Nova Scotia Steel and Coal Company, Limited, of New Glasgow, which concern, we understand, now forms part of the British Empire Steel Corporation. Although British shipbuilders tendered for the vessel, the Canadian offer was accepted because, at the time when the contract was placed, British yards were only prepared to build on the basis of a percentage of the total cost, and were not able to guarantee any definite date of delivery on account of the then prevailing strikes and fluctuations in the prices of materials. It is, perhaps, a record that such a large vessel was constructed without the purchaser employing a naval architect, all the details being settled personally by the owner in correspondence.

The yacht was built with scantlings 10 per cent. in excess of Lloyd's 100 A1 requirements, and the anchor and chain equipment is 100 per cent. in excess of that demanded under Lloyd's Rules. In order that the ship might be able to cruise in the shallow waters of the Bahamas and around Cuba and Florida, a light draught of 7ft. 6in. was adopted, and by discharging water ballast amounting to 58 tons, the vessel may be lightened till she draws about 6ft. 6in. This very small draught necessitated the somewhat unusual

beam of 28ft. 6in. Bilge keels are fitted and are 50ft. long by 10in. deep. With a view to making the vessel a good sea boat, all the sections from forward as far back as the engine-room are given an unusual amount of flare. The excess stability of the ship enables this extra weight to be carried without difficulty. In Fig. 3, and in the drawings reproduced in to-day's Supplement, some details of the construction of the hull and the lay-out of accommodation are given. It may be stated that the decks are laid throughout with teak, which was supplied by Messrs. Hoar and Brown, of London.

Brief reference may be made to the principal rooms, some views of which we show in Fig. 1 and in Figs. 4 to 7 on page 256. The owner's quarters aft are entered from a large vestibule on the main deck, giving access to the other rooms. In this passage is an electric lift by A. P. Steven, of Glasgow, which communicates with the wheel-house on the deck above. The other three rooms leading off the vestibule are the main saloon right aft—see Fig. 7—and the owner's sleeping cabin and study, Figs. 5 and 6 respectively. The main saloon is particularly roomy and well lighted, and has a breadth of 26ft. 3in. and a length of 16ft. 6in. Besides a large skylight, 10ft. by 8ft., there are ten windows of the Becklawatt type in the saloon. The dimensions of the owner's sleeping cabin are 15ft. 6in. by 15ft. 3in., and the study is 10ft. 3in. in length with a width of 9ft.

Below the main deck are three cabins, each 12ft. by 10ft., and two others 12ft. by 7ft., as well as the secretary's office and the wireless room, which are 12ft. by 11ft., and a bathroom. Aft there is the Baroness's cabin, 24ft. by 10ft., which runs the full width of the ship. The arrangement is such that every cabin, with the exception of the two smaller cabins, has a skylight. All the sidelights are of the "Orient" type, measuring 12in. diameter in the clear, and were supplied by the Carron Company. No cabin has less than two sidelights. A further feature of the sidelights is that all are fitted with a drain overboard from the drip pans, and all the drains are connected to one non-return sea-cock. This arrangement is a particularly desirable one when tropical showers have to be encountered.

Ventilation is provided by large down-draught Boyle type ventilators, designed to keep the cabins cool in the Tropics. The decoration adopted throughout is dull polished mahogany, with panels of an imitation marble known as "Calbonite." This material was supplied by Bells United Asbestos Company, Limited, of London, and the object of employing it was to reflect light as well as to avoid the shrinkage which would have certainly taken place had wood been employed. The material has the further advantage of being washable and practically indestructible, whilst its decorative effect may be described as very pleasing in character. The ceilings of the cabins, it may be noted, are covered with the Tynecastle Company's well-known ship's ceiling decoration.

Another prominent feature of the owner's quarters is that the deck within them is entirely without camber, which greatly adds to the comfort of the rooms. As shown in the illustrations—reproduced on page 256—deck pillars have been avoided as far as possible, a luxury which, however, entailed a considerable amount of strengthening. With a view to making the ship seaworthy for long ocean cruises, all the skylights and companion ways on the main deck are of an unusually strong type and are made in steel. The accommodation for the commander and officers is placed forward of the galley and pantry. The officers' mess room measures 14ft. 6in. by 9ft., and all the cabins are furnished with "Orient" side lights and cowl ventilation. The seamen's quarters are placed right forward. The arrangement of cabins is shown in the plans reproduced in the Supplement. On the bridge deck, which is 52ft. by 27ft. and is furnished with a curved overhanging front, there is a large wheel-house 15ft. by 11ft. 6in., to which access is also given from the owner's quarters below by the electric lift already mentioned.

Deck and Auxiliary Machinery.—Among the deck and auxiliary machinery the steering gear is of outstanding interest. It was designed by the owner, and was constructed by Clarke, Chapman and Co., Limited. Normally it is an ordinary hand gear, but power cylinders actuated by compressed air and working somewhat after the principle of a

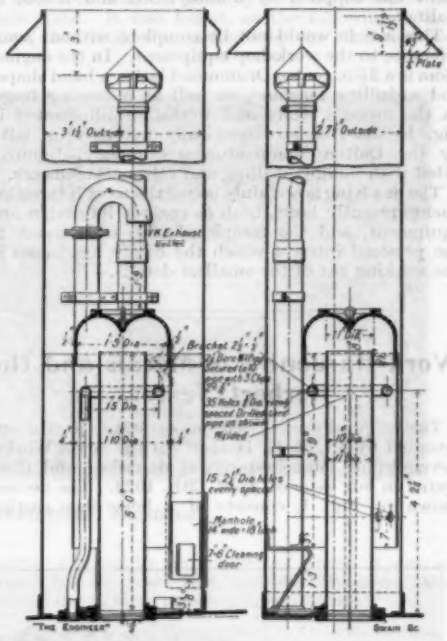


FIG. 2—FUNNEL WITH SPARK QUENCHER

hydraulic gear with a ram motion are employed. The valves controlling the air admitted to the cylinders are of the mushroom type. By merely opening a three-way air cock the hand gear can be power driven. Thus when steering by hand the quartermaster may instantly apply power to his wheel without the necessity of engaging clutches or other complicated gearing. In practice the gear works noiselessly and has, we learn, proved a complete success. The amount of compressed air used is remarkably small. Roller and ball bearings are fitted throughout, and by using elliptic gear wheels the hard over position is obtained by hand with but very little increase of pull on the spokes of the steering wheel. For the size of the vessel the steering is remarkably easy.

The windlass is made in cast steel and is specially arranged to deal with two bowers of 1¼in. cable as well as a third bower of ⅞in. cable, this being the stream chain, to which is connected a Trotman anchor of 8½ hundredweight, which renders it more serviceable. An electric motor of 14-kilowatt capacity, by Clarke, Chapman, drives the windlass through an overload safety clutch plate. There are two purchases on the main windlass, one of 2½ tons and the other of 4 tons direct on the barrels. The main anchors weigh 16 and 17 hundredweight respectively. The anchor and chain equipment was supplied by Richard Sykes and Son, Limited, of Cradley Heath. A derrick is provided which, in conjunction with the windlass, is designed to lift 4 tons.

A portable motor fire-engine of the Ravensbourne type, specially made to suit marine requirements, was supplied by Merryweather and Sons, Limited. This pump is designed for a duty of 2000 gallons of water per hour, and is furnished with 500ft. of hose. The yacht has a complete set of 4in. water-boring tackle, which enables water supply to be obtained on distant islands and thus insures a pure supply. The engine pumps directly into the ships tanks, or in the event of the source of supply being a long distance from the shore into the water boat referred to later. In addition to the motor pump there is a powerful portable hand pump. The boats are carried in a well, formed between the galley and the pantry—see to-day's Supplement—and comprise the following:—An auxiliary fishing boat, designed by Alfred Mylne, of Glasgow, 26ft. long by 8ft. beam, with a weight of 4 tons; a centre board sailing water boat of 18ft. 6in. by 7ft. beam, fitted with tinned brass tanks capable of carrying 17 hundredweight of fresh water. This boat has tanks in the bottom which serve as water ballast tanks when required, and it may also be regarded as an unsinkable lifeboat when the tanks are empty. The fire pump referred to above is of sufficient capacity to empty the water tanks in about two minutes, after which the boats are lifted aboard by the derrick. It may be mentioned that all the sanitary fittings, baths, &c., throughout the yacht were supplied by Morrison, Ingram and Co., Limited, Manchester, and J. Downton and Co., London. The navigating compass is of the vertical card type, made by Kelvin, Bottomley and Baird, Limited, of Glasgow, and the wireless equipment, the generator for which is fixed in the engine-room, is of the Siemens Brothers pattern.

MAIN PROPELLING AND AUXILIARY MACHINERY.

The engine-room is 29ft. long with a width of 28ft. 6in., and is situated partly under the galley, pantry, and the cold storage chamber. The main engines comprise two sets of Vickers-Petters hot-bulb marine oil engines, each with four cylinders 14in. in diameter and with a piston stroke of 16in. Each engine is designed to develop 220 brake horse-power when running at a speed of 275 revolutions per minute. In general the engines are of the makers' standard pattern, but the main circulating and bilge pumps were specially built to comply with the owner's view and specifications. The two pumps referred to are placed at the forward end of the engine, and are worm driven at a reduced speed of 70 revolutions per minute. The plungers are 6in. in diameter, with a stroke of 7in. The arrangement of pipes permits the engines to be cooled in four different ways. First, by the main circulating pump; secondly, by the bilge pump, which is identical in size; thirdly, by a three-throw ram ballast pump, which may be driven by either auxiliary engine; and, fourthly, by an electrically-operated turbine pump, the motor driving which takes current from either the dynamos or the storage battery. The main thrust bearings are also water cooled and are of the Michell type.

Reference may fittingly be made to the clutches between the engines and the propeller shafting. They were made by David Bridge and Co., Limited, and have exceptionally large friction surfaces. The outer rim is made so that it can be removed, giving access to the lining, enabling this to be renewed without disturbing any part of the main shafting or bearings. This arrangement gives full facilities for inspection and adjustment, a feature which

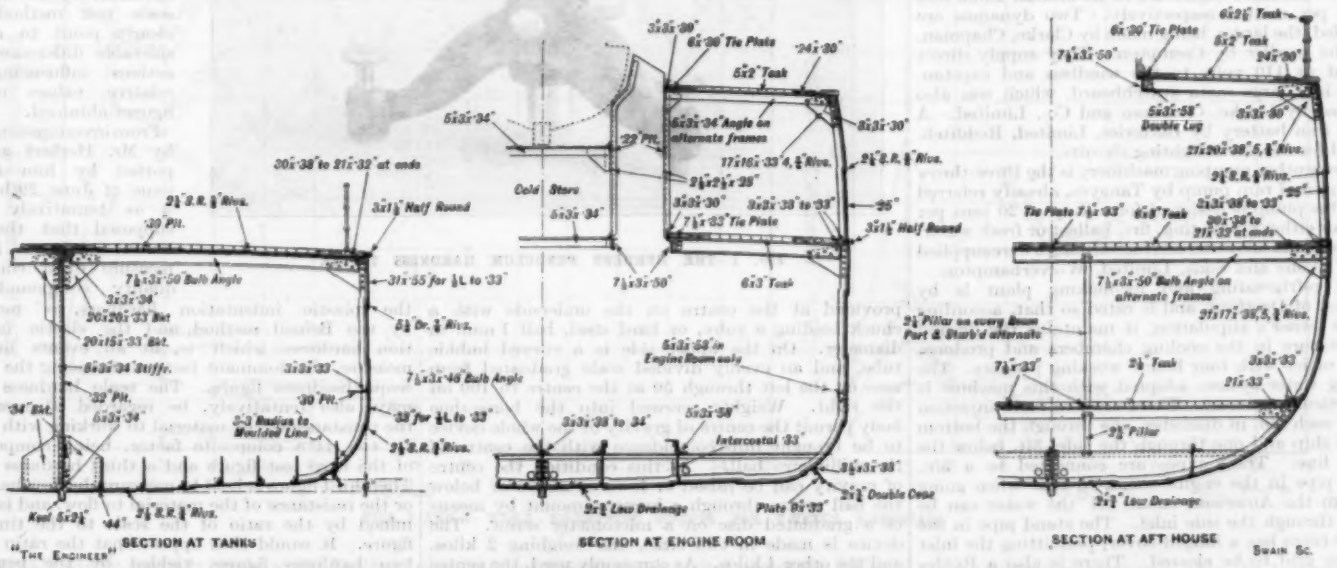


FIG. 3—HALF CROSS SECTIONS OF THE SEA KING

the owner considers is not sufficiently thought of by many builders. The clutch has another novel feature, for the rims of the clutches, which are 2ft. 6in. in diameter, have a deep groove turned in them, so that when lifted by a rope sling the clutch hangs fair in the sling and may thus be easily handled. The intermediate shafting is, like the engine crank shafts, 6½in. in diameter, and it is supported in self-oiling bearings, and made with solid coupling flanges, whilst the tail shafts are 7in. in diameter, and are furnished with specially designed couplings, enabling the shafts to be withdrawn from the outside. Lubricators fixed in the engine-room supply the stern tubes with grease. The propellers, which, to prevent corrosion, are made of Firth's rustless steel, were supplied by J. I. Thornycroft, Limited. Of the engine-room generally it may be said that no modern improvement in accessories has been overlooked. For indicating the speed at which the engines are running both tachometers and Harding's revolution counters are employed.

Spark-quenching Funnels.—Although the specially designed spark-quenching funnels fitted on this yacht were described in a letter to the Editor published in our issue of August 3rd last year, some reference to them may be made here. The illustration we reproduce in Fig. 2 shows the port funnel. The exhaust from the main port engine is carried up the stand pipe, which is 10in. in diameter. Over this pipe is placed a cast iron hood, terminating in a mild steel cylindrical body, and at the top of the hood a cleaning door is fitted. The whole of the engine circulating water is sprayed by means of pipe ring on to the top of the exhaust pipe and the hood. Further, the lower part of the hood is furnished with fifteen holes, 2½in. in diameter, which allow part of the cooling water to be blown through to the outer casing, thereby adding to the cooling effect. The base of the funnel is provided with a 3½in. diameter drain pipe, which stands 3in. above the bottom, so that water is always retained in the base. A strum box covers the drain aperture, thus preventing choking taking place. In addition to a 7in. by 6in. cleaning door, a manhole is provided at the base, and a 2in. brass plug for inspection purposes. The exhaust pipe from the second auxiliary engine is carried into the funnel and terminates in a bend, so that any sparks from it are quenched in the water below the outlet. The illustration given also shows the galley funnel and the hot water boiler chimney, which are carried up to within 15in. of the top of the main funnel casing. The arrangement described has been very successful, we understand, in bringing about a clean and quiet exhaust. The funnel arrangement described was built by Vickers-Petter, Limited, of Ipswich, to the owner's designs and instructions.

Auxiliary Engine-room Machinery.—The auxiliary engines include an 18 brake horse-power single-cylinder Vickers-Petter hot-bulb engine placed amidships, and a second auxiliary engine of 10 brake horse-power. Each engine drives a quadruple two-stage Reavell air compressor through a clutch. These compressors have capacities of 30 and 25 cubic feet of air per minute respectively. Two dynamos are provided, the larger, being made by Clarke, Chapman, and the smaller by Crompton. They supply direct current at 110 volts to the windlass and capstan. There is a large main switchboard, which was also supplied by Clarke, Chapman and Co., Limited. A nickel iron battery by Batteries, Limited, Redditch, is used for the yacht lighting circuits.

Among other pumping machinery is the three-throw silent geared ram pump by Tangyes, already referred to. This pump is designed for a duty of 20 tons per hour for either circulating, fire, ballast or fresh water. The fresh and salt water and fuel oil pumps were supplied by J. Evans and Sons, Limited, Wolverhampton.

The refrigerating and ice-making plant is by Seagers, of Dartford, and is rated so that, according to the owner's stipulation, it maintains the desired temperature in the cooling chambers and produces 45 lb. of ice with four hours' working per day. The cooling water system adopted with this machine is of particular interest. There are two main injection pipes, each 5in. in diameter, one through the bottom of the ship and one through the side, 3ft. below the water line. These pipes are connected to a 5in. stand pipe in the engine-room, so that when going through the American canals all the water can be taken through the side inlet. The stand pipe in the engine-room has a hinged cover, permitting the inlet strainer grid to be cleared. There is also a Royles twin-type strainer and a range of five valves for various duties. Each service is separate, including the salt water sanitary service for the ship. Any choking of the pipes by weed can be dealt with from the engine-room, which in practice is most satisfactory.

Fuel Oil Arrangements.—The main fuel oil is carried in a deep tank two frame spaces in length, with a division plate, which holds over 30 tons of fuel. Two double-acting hand pumps, by Evans, are provided, each with 1¼in. suction and duplicate dirt collectors and filters. The piping is so run that each pump can draw from either tank through either filter, and can fill up the ready-use tanks or can draw from one main tank and discharge to the other. Each of the two ready-use tanks contains sufficient oil for an eight hours' run. These tanks have wells in the bottom to collect dirt and water, and twin oil strainers of the owner's own design are fitted. By closing a three-way cock, the choked strainer may be withdrawn from its seat and cleaned. Both the main and auxiliary engines draw their oil supply from the tanks we have mentioned, and special oil gauge fittings by Hopkinson made to Lloyd's approval are used.

All the hot water required for the ship and the heating water is produced in a large vertical cross-tube boiler, which is coupled indirectly to a jacketed heating cylinder of about 80 gallons capacity. With this arrangement the boiler does not scale and one boiler serves for both duties. A small boiler of similar design is used in the galley. This heating plant was supplied by Lumbly, Son and Wood, of Halifax.

This article would not be complete without some reference to the workshop equipment. In the engine-room is a 3½in. centre Drummond lathe, a hand shaper and a drilling machine, as well as a brazing forge. In the owner's study and workshop—illustrated in Fig. 1—there is an electrically-driven 4½in. lathe by the Dalton Manufacturing Company, Limited, fitted with milling, drilling and other attachments.

The Sea King is certainly one of the most interesting yachts recently built, both as regards its design and equipment, and the completed ship owes much to the personal interest which the owner has taken in the working out of the smallest details.

Work-Hardening of Metals and the Herbert Tester.

THE "pendulum" hardness-testing instrument invented by Mr. E. G. Herbert, of the Atlas Works, Levenshulme, Manchester, was described and illustrated in our issue of April 13th, 1923. The device, shown in Fig. 1, consists of a horse-shoe casting

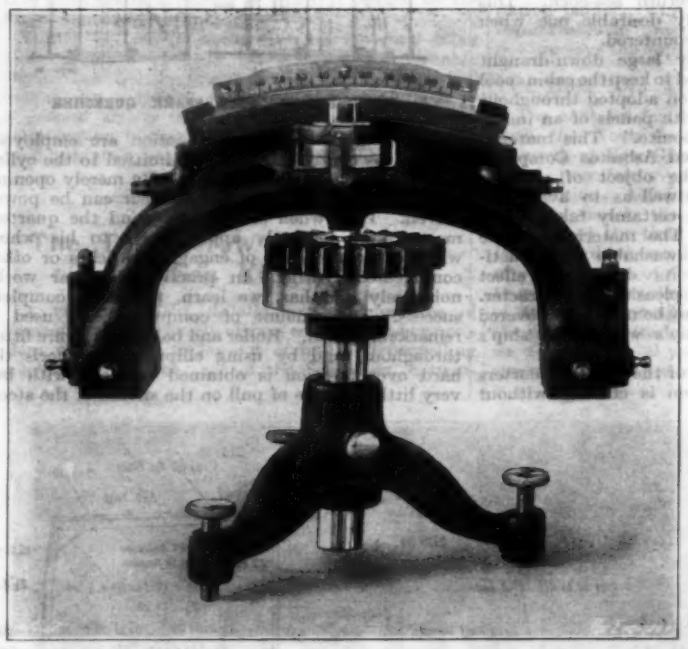


FIG. 1—THE HERBERT PENDULUM HARDNESS TESTER

provided at the centre on the underside with a chuck holding a ruby, or hard steel, ball 1 mm. in diameter. On the upper side is a curved bubble tube, and an evenly divided scale graduated from zero on the left through 50 at the centre to 100 on the right. Weights screwed into the horse-shoe body permit the centre of gravity of the whole device to be brought into coincidence with the centre of the millimetre ball. In this condition the centre of gravity can be raised or lowered above or below the ball centre through a known amount by means of a graduated disc on a micrometer screw. The device is made in two sizes, one weighing 2 kilos. and the other 4 kilos. As commonly used, the centre of gravity is adjusted until it is one-tenth of a millimetre below the centre of the ball. Interesting results have, however, been obtained by making this dimension—referred to by Mr. Herbert as the "length of the pendulum"—zero or negative.

Some hesitation, it may be remarked, has been expressed, even in our own columns, regarding the acceptance of the term "pendulum" as a description of the instrument, and of the term "length of the pendulum" as a name for the distance between the centre of gravity and the centre of the ball. Further acquaintance with the device has convinced us that such hesitation, in so far as it may be based on the fact that the periodic time *increases* as the "length of the pendulum" *decreases*, is not justified. As the length of a compound pendulum is decreased, the period shortens until the length is equal to the radius of gyration. At that length the period is a minimum, and as the length is farther decreased the period lengthens. The radius of gyration of the 4 kilos. tester is about 10 cm. As the "length of the pendulum" is, normally, about 0.01 cm., the device, regarded as a compound pendulum, is well within the range of increasing period.

The pendulum tester, as a means of measuring the hardness of materials, can be used in two totally distinct ways. In one it is rested on the article to be tested with the bubble at the 50 mark on the scale; that is to say, with the bubble vertically over the supporting ruby or steel ball. The instrument is then set swinging through a very small range by lightly touching it with a feather. The periodic time of the swing is taken as a measure of the hardness of the material under test, the time taken to make ten swings—that is, five double swings—being known as the "time hardness" figure. Three typical time hardness figures are:—Plate glass, 100; hard carbon steel, 65; lead, 3.

In the second method of using the device it is initially placed on the test specimen with the bubble divided by the 50 scale mark; that is to say, the instrument is set upright, as in the time test. It is then tilted until the bubble is divided by the zero mark. On its release from this inclination, the position which the bubble reaches at the end of the first swing is noted and is recorded as the "scale hardness" figure. For the same samples of the materials mentioned above, the following are the scale hardness figures:—Plate glass, 97; hard carbon steel, 88; lead, 0. In the case of lead no swing at all occurs, the device remaining in the tilted position, while for plate glass the device rocks during the first swing through an angle almost equal to the angle of the initial tilt given to it.

It will be seen that the two methods of working yield results of quite a different order. Thus, whereas by the time test, hard carbon steel is found to have a hardness figure which is 65 per cent. of that for plate glass, by the scale test its hardness is indicated to be over 90 per cent. of that of plate glass. This curious and interesting discrepancy, if we may call it by such a name, strongly suggests that the two methods measure two different properties, or sets of properties, of the material under test. From the results of researches conducted by Mr. Herbert we now seem to be fairly well justified in believing that such is definitely the case. The photographs reproduced in Fig. 2 give enlarged views of the indentations left on the specimen by the time and scale test methods, and clearly point to a considerable difference in the actions influencing the relative values of the figures obtained.

From investigations made by Mr. Herbert and reported by him in our issue of June 29th, 1923, it is tentatively to be supposed that the time hardness figure is the measure of a composite quality compounded of the plastic indentation hardness, as measured by the Brinell method, and the elastic indentation hardness which is, at all events in large measure, the dominant factor influencing the sclero-scope hardness figure. The scale hardness figure may, also tentatively, be regarded as measuring the resistance of the material to working with a tool. It, too, is a composite factor, being compounded of the time test figure and a third hardness figure. This third figure is held to measure the flow hardness, or the resistance of the material to flow, and is determined by the ratio of the scale to the time test figure. It would thus appear that the ratio of the two hardness figures yielded by the pendulum tester measures what may be regarded as being a simple, single property of the material, whereas each of the figures separately measures a complex of, at least, two simple properties.

In some recent research work, Mr. Herbert has been concentrating his attention upon the scale hardness figures obtained from different materials, and has arrived at results which seem to promise a considerable addition to our insight into the important phenomenon exhibited by metals in hardening as a result of being worked in the cold state. He was led to the results during an investigation of two possible alternative methods of conducting the scale test. As we have said above, the standard method of carrying out this test is to place the tester upright on the specimen, to tilt it until the bubble is at the zero mark, and then to release it and note

the position reached by the bubble at the end of the first swing. During the preliminary tilting of the pendulum by hand, the supporting ball is made by external force to roll out an elongated path on the specimen. Over the first portion of the ensuing free swing—while the bubble is moving from the zero to the 50 mark—the ball returns along this rolled path, but during the second portion of the swing—while the bubble is moving from the 50 mark to the mark that is to be read as the scale hardness figure—the ball is required to roll out a fresh path for itself.

As an alternative method of working the device might initially be placed on the specimen in a tilted position with the bubble at the zero mark. On release the ball would then be required to roll out it quite unsuitable for further working, although the amount of work-hardness could scarcely be detected by an indentation test of the Brinell type.

Since the Herbert time hardness test is, according to Mr. Herbert's view, an indentation test of a compound nature, it should fail, like the Brinell test, to reveal fully the hardening effect on metals after being worked cold. On the other hand, the scale hardness test, being in the nature of a rolling process, should be influenced by different factors. Experimental figures given us by Mr. Herbert clearly bear out this argument. Taking specimens of sheet metal passed a varying number of times through a rolling machine, he measured their hardness by both the time and the scale tests. It was found, as the following figures show, that while the hardness by the time test was

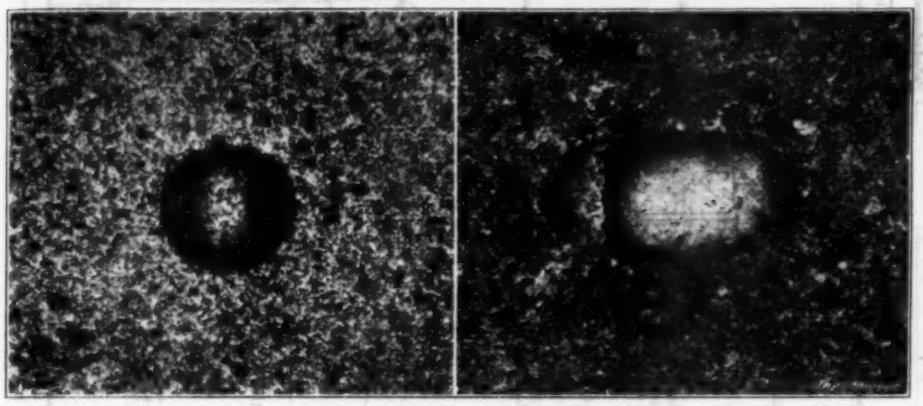


FIG. 2—TIME AND SCALE INDENTATIONS, MAGNIFIED

both portions of its path. As a second alternative, the device might be applied tilted with the bubble at 100 and then tilted by external agency until the bubble was at zero. On release the ball would find both portions of its path already rolled out. On investigation it was found that these methods gave quite different hardness figures from those yielded by the standard, or half-path, method. The no-path method resulted in the hardness figures from the softer materials of a given series being crowded together. The whole-path method resulted in the crowding of the figures relating to the harder materials. The standard method gave an open scale throughout, and although deemed less logical than either of the others, was adopted for that reason.

At first it was not understood why the scale hardness figure should differ according as the ball was allowed to roll out its path wholly, partially, or not at all. Further investigation, however, led Mr. Herbert to the conclusion that the readings on a rolled path were higher than those on an unrolled, because the metal as a result of the preliminary rolling had become work-hardened. From that discovery, it was but a natural step to develop a method whereby the pendulum instrument could be used as a means of determining the work-hardening propensity of any given metal in the normal state.

It may here be noted that most metals exhibit the phenomenon of hardening as a result of being worked in the cold state. The degree of hardness produced by such working is not, however, rendered fully apparent by a simple indentation test carried out on the metal after the cold working. For example, it has been found that metal rolled cold or drawn through dies may be work-hardened to an extent rendering scarcely affected by the number of passes, it was, as judged by the scale test, considerably more than doubled after thirty passes through the rolls.

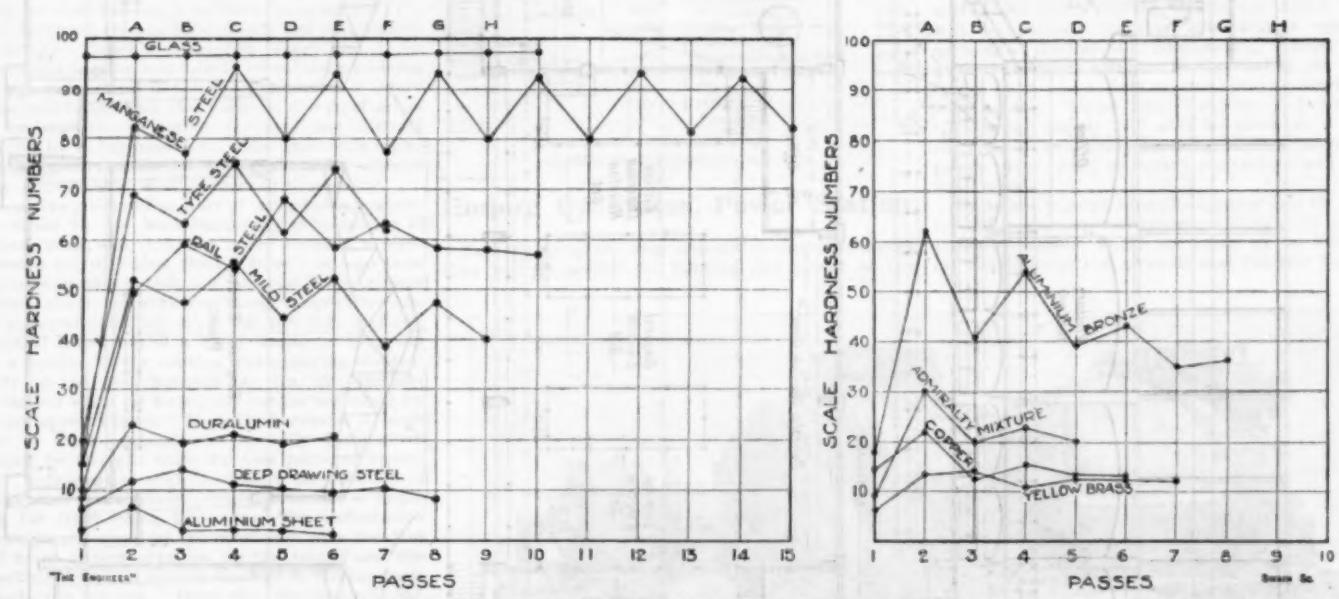
Passes.	Time hardness.	Scale hardness.
3	18	19
6	17	20
9	19	26
12	19	27
15	20	28
30	21	43

Again, two samples of steel used for deep stamping had been found in practice to give good and poor results respectively. Under the time test the good steel gave a figure of 12 and the poor steel a figure of 15, a difference quite insufficient to explain the different behaviour of the metals in practice. But under the scale test, the good steel exhibited a hardness figure of 9 and the poor steel one of 38. This great difference appears to indicate that the poorness of the second steel was a result of its having previously been considerably work-hardened, possibly at the rolling mills.

It seems clear from these facts and figures that the Herbert scale test, applied in the standard manner, gives us a means of measuring the degree of work-hardness possessed by a given specimen of metal, provided we know the scale hardness figure for a sample of the same metal, which is definitely without work-hardness. Mr. Herbert has, however, carried the matter further. He has sought to develop a method whereby from one specimen of normal metal he may determine the propensity of the metal to develop work-hardness. To this end, he uses his pendulum tester not only as a means of measuring the hardness, but also as a means of producing that portion of it which we call the work-hardness. The procedure is quite simple. The standard method of carrying out the scale test—what we have called the "half path" method above—is abandoned. The instrument instead is initially placed on the specimen in a tilted position, with the bubble at zero. On its release, it swings over, rolling out the whole of the ball path, and the maximum scale reading reached is noted. It is, however, not allowed immediately to swing back, but is tilted still further in the direction of its first swing, until the bubble is at the 100 mark. Thereupon, it is released, and a second reading of the maximum inclination reached is taken, the graduations being read reversed. During this second swing the ball is, of course, rolling in a previously formed path. This path has been work-hardened by the previous swing, and as a consequence the second reading is different from the first, being in general higher. The second swing is continued by hand until the bubble is again at zero. The third swing then takes place, the ball rolling in a path which has had its hardness further increased by the work done on it during the second swing. The process is then repeated until the readings successively obtained become constant, or substantially so.

As a means of specifying the work-hardening propensity of a metal, Mr. Herbert has devised a system of notation which indicates, not only the degree of hardness reached, but also the time taken to reach it. He indicates the amount of work-hardness by the difference between the maximum scale reading attained and the original reading on the first swing. The rapidity with which the work-hardening takes place is indicated by a prefixed letter of the alphabet, A indicating that the maximum scale reading was exhibited at the end of the second swing, B at the end of the third swing, C at the end of the fourth, and so on. Thus, a steel which gave an initial scale reading of 20 and a maximum reading of 75 at the end of the fourth swing, would as regards its work-hardening propensity be designated C 55.

In Figs. 3 and 4 the readings obtained from glass and eleven different metals are indicated. Glass, it will be seen, is entirely without work-hardening propensity, the reading of 97 being repeated at all swings. It would appear that this result does not arise from the fact that glass is too hard to be indented; actually, the test leaves a very perceptible indentation in it. Manganese steel in its normal state gives a scale reading of 15, a figure equal to that given by a good mild steel. But at the end of the second swing or pass, the figure rises to 83, while at the end of the fourth swing, the scale hardness figure is 95, equal to that of hard tool steel. It will be noted that after the second swing the scale readings are alternately high and low, the high values being approximately 95, and the low values about 80. The zigzag effect is noticeable in most of the other curves, and is believed by Mr. Herbert to be produced

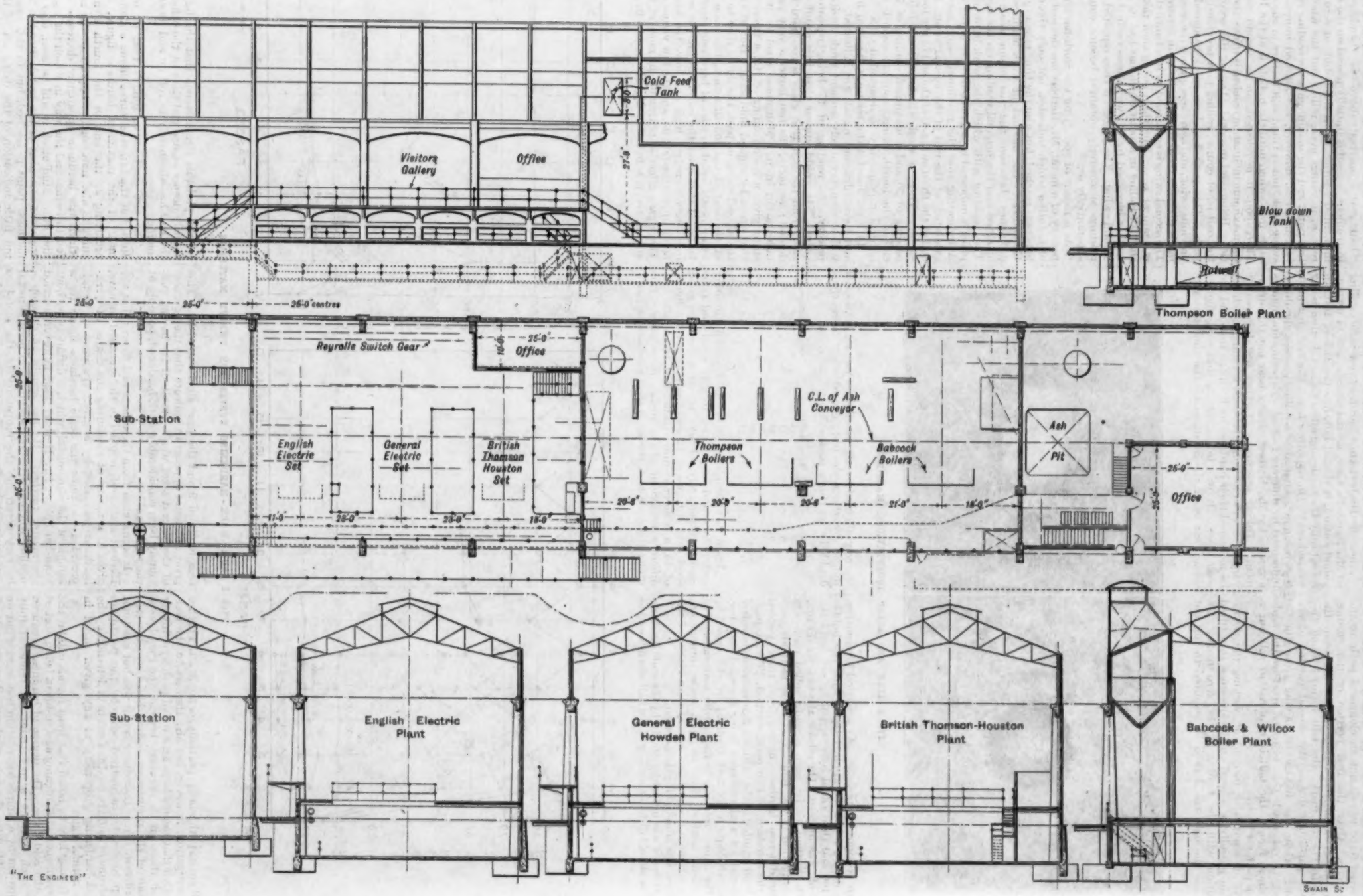


FIGS. 3 AND 4—WORK-HARDENING CURVES FOR TWELVE MATERIALS

by the probable circumstance that the ball path is slightly deeper at one end than at the other, so that the ball has alternately to roll up and down a slight incline.

The tire steel curve follows that of manganese steel, but the rail steel curve shows a slower attainment of the maximum hardness figure, the point occurring at the end of the fourth swing. This curve is also noteworthy, because of the manner in which the hardness apparently decreases after the fourth swing, and the way in which the zigzag effect dies out. Mild steel, it will be seen, also shows an apparent softening of the metal after the maximum hardness point is reached, but in this case there is but little indication of the dying-out of the zigzag effect. We think that the apparent "work-softening" effect can be disregarded, and that there is no corresponding phenomenon actually occurring in the

PLAN AND SECTIONS OF THE POWER HOUSE AT THE EMPIRE EXHIBITION, WEMBLEY



metal. Mr. Herbert himself is inclined to the same view, and suggests that the apparent phenomenon is an instrumental effect, resulting from the gradual working in of the ball into the metal, and an accompanying decrease in the radius of curvature of the ball path. A test on gold—a half-sovereign—which we asked Mr. Herbert to carry out, shows the "softening" effect and the gradual dying out of the zigzags after the manner of the rail steel.

For the time being, as there is still doubt about the extent of the instrumental influence it is, perhaps, best to adhere to Mr. Herbert's plan of measuring the extent of the work-hardness by the difference between the maximum scale reading obtained and the first reading. It may, however, be found, we suggest, that a more scientifically satisfactory procedure would be to draw a smooth curve through the plotted points, neglecting the first, and to extend this curve to the left until it cuts the vertical axis. The intercept of this curve on the vertical axis when compared with the original scale reading would, it appeals to us, possibly prove a less arbitrary measure of the work-hardening propensity than the maximum scale reading observed.

The curve for the deep drawing steel is worthy of special notice. There is indicated only a small propensity to work-harden, a result in keeping with the known fact that the material tested was particularly suitable for difficult stamping operations. An ordinary indentation test fails to reveal the particular property of the metal in this respect, so that it might well be concluded that the value of the steel arises from its ductility or other property not directly measured by a hardness test. Mr. Herbert's curve clearly suggests that its value arises from the absence of any considerable work-hardening propensity.

The curves given in Fig. 5 are of remarkable interest. They relate to the work-hardening propensities of tin-plate, thick and thin, the latter actually a piece of tobacco tin, 0.0055in. thick. It will be seen from the two lower curves that the material in its original condition shows no work-hardening propensity—the thick material definitely none and the thin material a doubtful indication of a slight amount. Scraping away a portion of the coating and applying the test directly to the steel beneath the tin, Mr. Herbert was startled when he found the results indicated by the two upper curves. In both instances a large degree of work-hardness was speedily manifested. It might be thought that the two pairs of curves merely indicate the work-hardening propensities of tin and steel respectively. Such, however, is apparently far from being the case. The indentation hardness as measured by the pendulum time test was found to be almost identical for the tinned and the scraped surfaces, and in both cases to be the hardness of steel, not of tin. Does the tin coating, Mr. Herbert asks, actually prevent the work-hardening of the underlying steel? The rolling of lead into foil is known to be greatly facilitated by depositing a thin layer of tin on the lead. Has the coating of tin on tin-plate a similar beneficial effect, and, if so, should not all sheets intended for deep stamping be tinned?

The coating of metals to be worked cold with other metals or substances for the purpose of facilitating the cold working, is a definitely established practice, although the *rationale* of the process may not previously have been completely understood. In preparing steel rods for drawing down into wire, the rods are pickled in a dilute solution of hydrochloric acid. As a result, the scale is removed, and, in addition, the rods are left with a brown coating of ferric hydrate. This "browning" is a very important factor in the success of the subsequent drawing operations, and every care is taken not to destroy it. It may be that its real function is to reduce the tendency of the steel to work-harden. Again, steel is sometimes coated with copper before being drawn down into wire. Copper is also applied to gold in the drawing of fine gold wire, but it would appear that the prime reason for doing so is to permit the drawing to be carried to a smaller section than would otherwise be possible. At the same time, we know from a test referred to above that gold has quite a marked work-hardening propensity, and it may be that the copper coating is beneficial in preventing the development of such propensity. The coating of tungsten with a ductile metal, such as gold, silver or copper, has been proposed in connection with the manufacture of drawn-filament lamps.

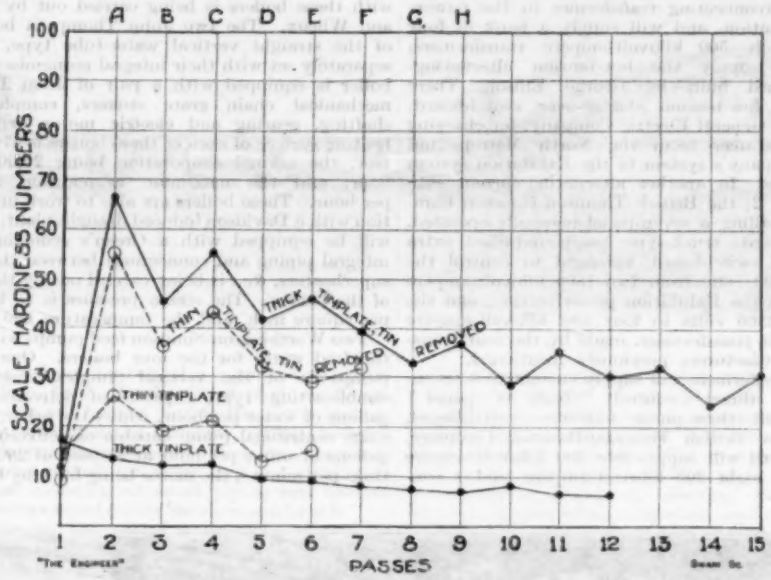


FIG. 5—WORK-HARDENING CURVES FOR TIN-PLATE

By way of conclusion, we give below a list of the work-hardening figures of various materials, as determined by Mr. Herbert. They are set forth in accordance with the scheme indicated above, whereby the rapidity of work-hardening is represented by an alphabetical prefix. All the figures were obtained with a pendulum tester weighing 4 kilos., having a steel ball 1 mm. in diameter, and a pendulum length of 0.1 mm.

Work-Hardening Figures.

Manganese steel	C80	Gold	B31
Stainless steel	C67	Admiralty bronze	A22
Rustless iron	C62	Wrought iron	A22
H.S. steel (annealed)	C59	Duralumin	A15
Rail steel	D58	Yellow brass	B8.5
Tire steel	C55	Cast copper	B8
Tin-plate, de-tinned	A54	Deep stamping steel	B8
Semi-steel cast iron	D51	Aluminium sheet	A4.5
Aluminium bronze	A47	Glass	0
Cast iron	B46	Mica	0
Mild steel	C40	Tin-plate	−3.5

Empire Exhibition, Power Station.

FOR supplying the large amount of electrical energy that will be needed for lighting and power at the British Empire Exhibition, a power station is being erected in the Palace of Engineering, and from the gallery, the position of which will be seen in the plan on the opposite page, visitors to the Exhibition will be able to view the plant at work. The various machines have been supplied by members of the British Electrical and Allied Manufacturers' Association and the British Engineers' Association. In addition to the current drawn from the power station, there is to be an alternating current supply, which will be obtained from a sub-station in the Palace of Industry, whilst direct current will also be provided by steam and internal combustion engines in the Palace of Engineering and by a rotary converter sub-station. In the power station which will supply alternating current, three turbo-alternators, with a total capacity of 4500 kilowatts, are being erected. The alternating current sub-station, which will be supplied from the North Metropolitan Power Company's mains, will have a capacity of 2000 kilowatts, whilst a reciprocating engine direct current plant will represent a capacity of 1000 kilowatts, thus making a total capacity of 7500 kilowatts in all.

Each of the alternators in the power-house will generate three-phase, 50-cycle current at a pressure of 3000 volts and feed sub-stations equipped with static transformers supplying 415-volt, three-phase current on a four-wire system, and 240-volt, single-phase current. From the North Metropolitan Power Company's station 11,000-volt, three-phase, 50-cycle current will be supplied to the sub-station, where it will be transformed down to 415-volt current by means of four 500 kilovolt-ampère transformers. An interconnecting 11,000-volt armoured cable is being provided between the North Metropolitan Company's power station and the station at the Exhibition, and this interconnector is joined up to a 1000-kilowatt static transformer.

The direct current reciprocating plant, which is being installed by members of the British Engineers' Association, will consist of a horizontal tandem compound Paxman-Lentz steam engine, running at 130 revolutions per minute, and directly coupled to a 300-kilowatt 220–240-volt generator, built by the Electric Construction Company; a twin type Blackstone crude oil engine driving a 180-kilowatt 220–240-volt generator, built by the English Electric Company; a four-cylinder vertical cold-starting Ruston-Hornsby oil engine driving a direct-current 220–240-volt generator built by Crompton and Co., Limited, and a semi-stationary combined boiler and engine installation complete with condensing plant and water cooler. This engine, which has been built by Richard Garrett and Sons, Limited, is to drive a 175-kilowatt direct-current generator built by the English Electric Company, the speed of the set being 170 revolutions per minute, and the voltage the same as that of the other direct-current generators. All this direct-current plant will be fed into a common network, which will also be supplied with current from a rotary converter sub-station, containing B.T.H. and English Electric rotary converters, each rated at 500 kilowatts. There is also to be a 500-kilowatt rotary converter on the stand of the General Electric Company.

The general supply for the grounds and buildings will be taken from a three-phase four-wire network working at 415 volts, which will also supply 240-volt single-phase current, whilst the direct current will be derived from a 220–440-volt three-wire network in the Palace of Engineering. Direct current at these voltages will also be supplied to the Amusements Park and to one or two special contrivances, such as the "Never Stop" railway. A 3000-volt, three-phase supply will also be given to a limited number of exhibitors showing and operating large power plant, such as rotary converters and mining machinery.

Up to the present time the applications for current for lighting and power represent a capacity of about 10,000 kilowatts, which are made up as follows:—(*a*) For lighting the grounds and exterior buildings,

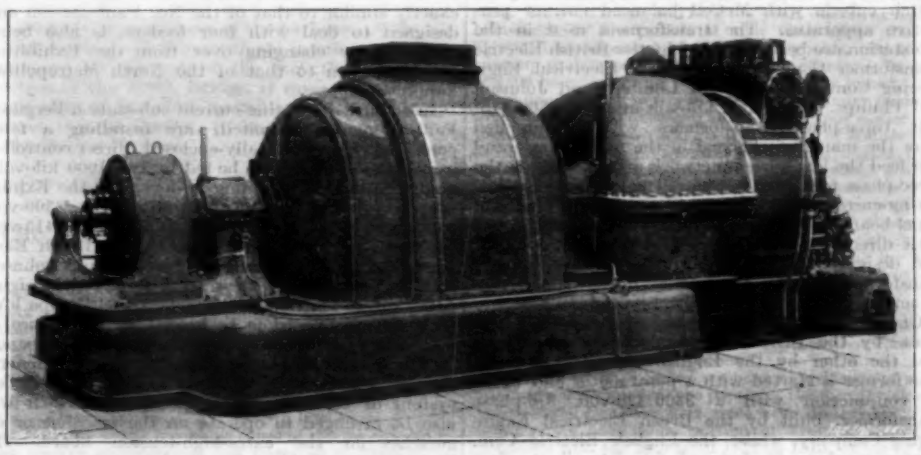


FIG. 1—1500 KILOWATT B.T.H. TURBO-GENERATOR

exclusive of the Amusements Park, 850 kilowatts; (*b*) for the lighting of the Palaces of Engineering and Industry and the Conference Hall, 400 kilowatts; (*c*) for lighting the principal restaurants, 550 kilowatts; (*d*) for power and lighting supply for the exhibitors in the Palaces of Engineering and Industry, 2000 kilowatts; (*e*) for power for the "Never Stop" railway, 750 kilowatts; (*f*) for power and lighting for the Amusements Park, 1350 kilowatts; (*g*)

for the colonial and Government buildings, 1600 kilowatts; (*h*) for three-phase supplies at 3000 volts, 1500 kilowatts; and (*j*) for miscellaneous supplies, 1000 kilowatts. The Stadium is to be supplied from an independent sub-station equipped with transformers with a capacity of 150 kilowatts and fed from the North Metropolitan Power Company's system. The main Exhibition grounds will be illuminated with about 560 lighting columns, fitted with a special globe lantern designed by the architects, Messrs. Simpson and Ayrton, each column being provided with 600-watt gas-filled lamps. The exterior of the main buildings will be illuminated on the flood lighting system.

The power-house plant, supplied under contract with the "Beama," consists of (*a*) a 1500-kilowatt turbo-generator—see Figs. 2 and 3—built by the British Thomson-Houston Company, and fitted with condensing plant and auxiliaries built by Cole, Marchent and Morley, Limited, of Bradford; (*b*) a 1500-kilowatt set, complete with condensing plant, built by the English Electric Company; and (*c*) a James Howden-General Electric Company's set of the same output, fitted with condensing plant and auxiliaries, built by James Musgrave and Co., Limited, of Bolton. All these sets have been designed to run at 3000 revolutions per minute, and to generate three-phase current at a pressure of 3300 volts and at a periodicity of 50 cycles per second.

The main switchgear, which is being installed by A. Reyrolle, Limited, consists of a 15-panel truck-type, compound-filled, remote-controlled, electrically-operated board designed for controlling the generators, feeders and the main sub-station for the 3300-volt supply, and is complete with the master control switches. A Tirril regulator, made by the British Thomson-Houston Company, is to be mounted on the control board so that it can operate in conjunction with any one of the three generators. The neutral earthing equipment, which is being supplied by A. Reyrolle and Co. and Everett Edgcumbe, will consist of three single-phase remote-controlled pillar-type oil switches, one for each machine, which will be operated from the master control board, and will be arranged for earthing the neutral points of one of the three machines, through special earthing resistances built by Everett Edgcumbe. A 60-cell 150 ampère-hour storage battery, for operating the Reyrolle switchgear and for emergency lighting, is being supplied by the makers of the Accumulator Association. For charging the battery a motor generator consisting of a 415-volt three-phase 50-cycle motor coupled to a direct-current generator is being installed by Submersible Motors, Limited, and the control panel for the machine has been built by the General Electric Company. A single-chimney type natural-draught cooling tower, designed to cool 175,000 gallons of water per hour from 92 deg. Fah. to 75 deg. Fah., is being erected by the Davenport Engineering Company, Limited, and a second cooling tower, of similar capacity and characteristics, is also being installed by the Premier Cooler and Engineering Company.

In the power-house sub-station, to be seen on the left of the plan—there is to be a 1000 kilovolt-ampère 11,000/3300-volt three-phase transformer, which will be supplied from the mains of the North Metropolitan Electric Supply Company, the output side of the transformer being connected to the main Reyrolle switchboard in the power station. For controlling the extra high-tension supply from the North Metropolitan Company to this transformer the General Electric Company is installing a 1000 kilovolt-ampère 11,000-volt truck-type boiler plate switch cubicle with McColl balanced current protective apparatus. The transformers used in the sub-station are being supplied by the British Electric Transformer Company, the Brush Electrical Engineering Company, Ferranti Limited, and Johnson and Phillips. Four 500 kilovolt-ampère, 3300/415-volt three-phase transformers will be supplied from the main switchboard in the power-house and will feed the low-tension network at 415 volts on the three-phase four-wire system. The low-tension alternating-current switchboard will consist of a nineteen-panel board of the protected iron-clad type, equipped with direct control loose-handle type oil switches, and designed for controlling the four 500-kilowatt transformers on the sides, this board being constructed by Allen West and Co., Limited.

One of the 500-kilowatt rotary converters has been built by the British Thomson-Houston Company and the other by the English Electric Company. The former is started with a pony motor and works in conjunction with a 3300/320-volt 3/6-phase transformer, built by the Brush Electrical Engineering Company, whilst the English Electric Company's machine is designed for "tap" starting, the 3/6-phase transformer being wound for the same voltage as that belonging to the British Thomson-Houston Company's machine. Both transformers are to be connected to the main switchboard in the power station.

The Park Royal Engineering Company is installing an eight-panel 440/220-volt three-wire switchboard, arranged for controlling the output of the rotary converters, and that from the direct-current generators, which are to be shown in operation in the Palace of Engineering. This board will control the supply to the three-wire direct-current network. George Ellison and Co., Limited, are installing in No. 1 sub-station a fifteen-panel low-tension alternating-current switchboard of the protected ironclad type. This board will be supplied from the North Metropolitan Company's sub-station adjoining, and this company is equipping its sub-station with an 11,000-volt extra high-tension switchboard, made by the British Thomson-Houston Company, and designed for controlling the two ends of a ring main. The board will also control the supply to the 1000-kilovolt-ampère interconnecting transformer in the power-house sub-station, and will supply a bank of four 11,000/415-volt 500 kilovolt-ampère transformers, which will supply the low-tension alternating-current board built by George Ellison. There is to be a low-tension change-over switchboard, built by the General Electric Company, for charging four feeders over from the North Metropolitan Supply Company's system to the Exhibition system or *vice versâ*. In another alternating-current sub-station (No. 2) the British Thomson-Houston Company is installing a seven-panel manually-operated, totally-enclosed truck-type compound-filled extra high-tension switchboard, arranged to control the input at 3300 volts from two 1500 kilovolt-ampère feeders from the Exhibition power station, and the supply at 3300 volts to four 500 kilovolt-ampère 3300/415-volt transformers, made by the four transformer manufacturers previously mentioned.

These transformers will supply current to a seventeen-panel direct-control "back of panel" type 415-volt three-phase four-wire switchboard, built by the British Thomson-Houston Company, and the board will supply five 500 kilovolt-ampère feeders and eight 200 kilovolt-ampère feeders connected to the low-tension network of the Exhibition. A 415-volt four-wire three-phase change-over board exactly similar to that of the No. 1 sub-station and designed to deal with four feeders, is also being provided for changing over from the Exhibition supply system to that of the North Metropolitan Supply Company.

In a third alternating-current sub-station Ferguson Pailin and Co., Limited, are installing a four-panel truck-type totally-enclosed direct-controlled ironclad switchboard to be fed by two 1000 kilovolt-ampère 3300-volt incoming feeders from the Exhibition power station and controlling the 3300-volt supply to two 500 kilovolt-ampère 3300/415-volt three-phase transformers made by the Brush Electrical Engineering Company, Limited, and Johnson and Phillips. From these transformers an eight-panel direct-controlled "back of panel" type low-tension switchboard is to be fed at a pressure of 415 volts. The two incoming transformer panels of this switchboard, which was built by the General Electric Company, are equipped with the McColl system of balanced-current protection, which will also be arranged to operate on the transformer oil switches on the extra-high-tension board. The low-tension switchboard will also control six 400-ampère outgoing feeders supplying the four-wire network at the Exhibition. There is also to be a sub-station for colour lighting, and in this station there are to be liquid dimming equipments, each rated at 250 kilowatts and capable of absorbing 40 per cent. of the line voltage. Allen West and Co., Limited, are supplying this dimming apparatus.

The boiler plant is being installed by Babcock and Wilcox, Limited, and by John Thompson Water Tube Boilers, Limited, the work being practically equally divided between these two firms. There are two land type Babcock boilers, equipped with an integral superheater and double chain-grate stokers with the necessary reduction gear and electric motor drives. Lea coal meters are being fitted to each stoker. Each of these boilers has a total heating surface of 6182 square feet, and is capable of a normal evaporation of 20,000 lb. per hour and a maximum evaporation of 25,000 lb. per hour. Green's economisers are being fitted to both these boilers. Induced draught plant is also being installed by Davidson and Co., of Belfast. All the pipe work associated with these boilers is being carried out by Babcock and Wilcox. The two John Thompson boilers are of the straight vertical water-tube type, and are separately set with their integral economisers. Each boiler is equipped with a pair of John Thompson mechanical chain-grate stokers, complete with shafting, gearing and electric motor drive. The heating surface of each of these boilers is 4700 square feet, the normal evaporation being 20,000 lb. per hour, and the maximum evaporation 25,000 lb. per hour. These boilers are also to work in conjunction with a Davidson induced draught plant, and each will be equipped with a Green's economiser. All integral piping and connections between the boilers, superheaters, &c., is being carried out by the makers of the boilers. The steam pressure is to be 220 lb. per square inch, and the temperature 600 deg. Fah.

Two Worthington-Simpson feed pumps will provide the feed water for the four boilers. One of these pumps is of the vertical Simplex steam-driven, double-acting type, capable of delivering 10,000 gallons of water per hour, whilst the other is a four-stage centrifugal pump capable of delivering 10,000 gallons of water per hour at a speed of 2800 revolutions per minute, the motor being built by Crompton and Co., Limited. United Water Softeners, Limited, are installing a 3ft. 6in. "Permutit" water softener designed oo deal with 1000 gallons of water per hour, and the plant is to be arranged to treat water from the mains of the Colne Valley Company for make-up purposes. There is also to be a Kennicott water softener, designed to deal with 1000 gallons per hour, which will also treat water from the same source for make-up purposes.

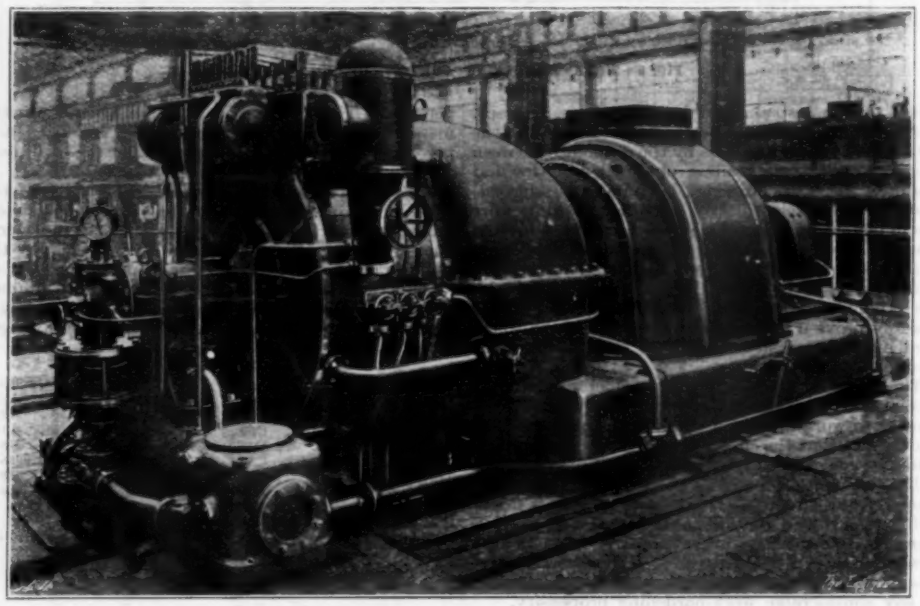


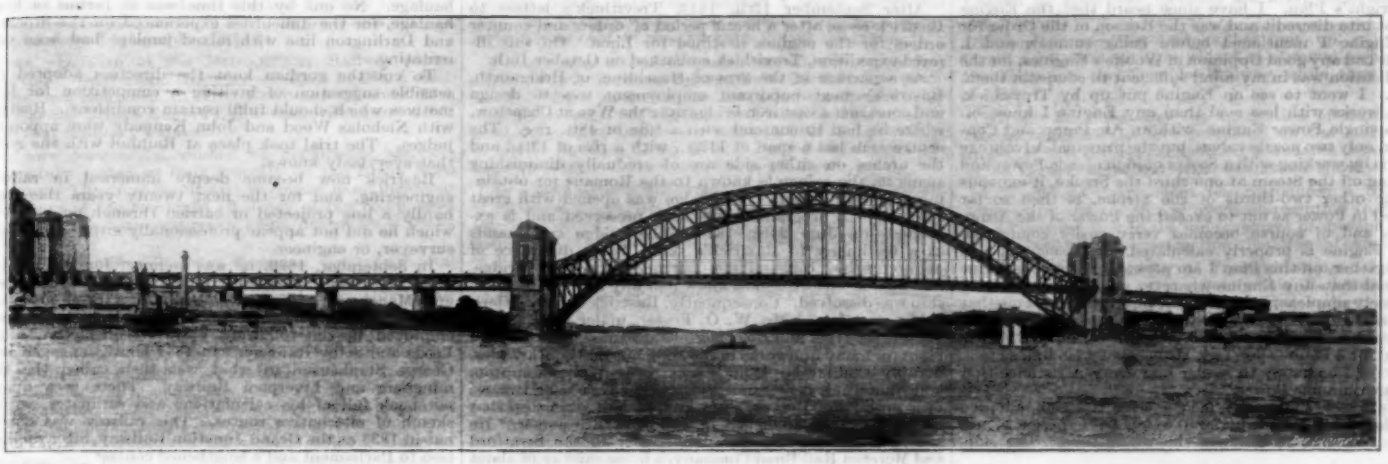
FIG. 2—1500 KILOWATT B.T.H. TURBO-GENERATOR

A complete coal-handling installation, consisting of an electrically operated wagon tippler, arranged to receive fully loaded coal wagons from sidings and to discharge them into a coal store adjoining, is being installed by the Mitchell Conveyor and Transporter Company. The coal will be fed by gravity from the hopper in the coal store on to an underground cross conveyor approximately 52ft. long, which will transport it to the main conveyor, which is to be approximately 350ft. long, and this conveyor will discharge the coal into a patented automatic skip hoist arranged to elevate the coal up to bunker level, where it will be discharged on to the bunker conveyor, which is to have a travelling discharger arranged to deposit the coal at any point in the bunkers. A Mitchell continuous automatic weighing machine is to be employed on the main long conveyor, and also a weighing equipment made by Samuel Denison and Sons, Limited. For the purpose of hauling coke wagons to and from the tippler on the sidings, Ransome and Rapier are supplying an electrically driven capstan.

Ash-handling plant of the water-sealed type is being installed by Babcock and Wilcox, Limited. The ashes will fall continuously from the boilers into specially constructed ash tanks, fitted with revolving paddle mechanism, by means of which the ashes will be continuously removed from the tanks

ACCEPTED DESIGN FOR THE SYDNEY HARBOUR BRIDGE

DORMAN, LONG AND CO., LIMITED, MIDDLESBROUGH, ENGINEERS AND CONTRACTORS



and deposited on the belt of a conveyor which removes them from the basement and discharges them into an ash bunker outside the power station. With the exception of integral piping between the boilers, superheaters, economisers, &c., the whole of the piping system for steam feed and circulating water, and including all small piping and connections, is being carried out by Stewarts and Lloyds.

For carrying the cables a complete system of earthenware ducts has been laid by the main contractors, McAlpine and Son, the material being supplied through the Cable Makers' Association and the General Electric Company. The high-pressure and extra-pressure cables supplied by the Cable Makers' Association will be paper-insulated, lead-covered and wire-armoured cables, whilst the 415-volt four-core cables for the general distribution will be paper-insulated and lead-covered, the whole of the material being made to the British Engineering Standards Associations' specifications. The network is to be controlled by distribution pillars of standard type, and between fifty and sixty of these pillars will be used. In the Amusements Park, the Pirelli cable system for the main 415-volt alternating-current supply will consist of four-core paper-insulated, lead-covered cables either laid direct in clay, or, alternatively, wire-armoured, and the network is to be controlled by distribution pillars, made by Lucy and Co. The direct-current cable system will consist of single-core paper-insulated lead-covered cables, laid directly in the clay, or, alternatively, wire-armoured cables will be used.

The consulting engineers are Sparks and Partners, the illuminating expert Mr. Haydon T. Harrison, and the chief engineer to the Exhibition, Mr. E. H. Parsons, to whom we are greatly indebted for assistance in the preparation of this article.

The Sydney Harbour Bridge.

WE have received from Dorman, Long and Co., Limited, of Middlesbrough, the following particulars of the Sydney Harbour Bridge, for which, as we announced last week, they have secured the contract:—

The proposed bridge across Sydney Harbour has been under consideration in New South Wales for over thirty years. In view of the urgent necessity for improving communications, the matter was taken up actively by the present Government, and an Act of Parliament was passed in 1922 authorising the construction of a bridge to cross the harbour in one span at a height sufficient to allow the passage of the largest liners.

Specifications were prepared by Mr. J. J. C. Bradfield, M. Inst. C.E., Chief Engineer of the New South Wales Government, which defined the exact position of the bridge and provided for four railway tracks as well as an 80ft. width of roads and footways, but threw upon tendering firms the entire responsibility for preparing the designs and the erection scheme. In response to an invitation open to all the world, tenders were submitted by two British, one Canadian, and one American bridge-building firms. Tenders were also sent in by two Australian firms, and it is known that the project received the consideration of continental manufacturers. The specifications mentioned that importance would be attached to the æsthetic features of the designs put forward. Dorman, Long and Co. devoted special attention to this, realising that a bridge of such great magnitude, to be constructed in a situation unique in its natural beauty, must be inherently attractive in its outline and dimensions, and that any decorative or architectural features introduced should be in keeping with the character of the bridge and its surroundings.

The company submitted alternative designs for a cantilever bridge, a cantilever arch bridge, and an arch bridge with various arrangements of the architectural treatment and span, making in all seven alternative tenders. The accepted tender is that for an arch bridge—which is illustrated by the accompanying engraving, showing the structure as it will appear when completed—and the principal opening of which is a single arch of 1650ft. span with heavy decorative granite abutment towers. The total length of the arch and of the approach spans will be 3770ft., and the head room for vessels passing in or out of the harbour will be 170ft. at high water. The height to the top of the arch will be 450ft.

This will constitute by far the largest arch bridge in the world, the nearest to it having a span of about 1000ft. It will also rank among the largest of any type of bridge, being exceeded only by the Forth and Quebec cantilever bridges. An exceptional feature is the unusually heavy rail and roadway accommodation, which necessitates a total width of bridge of 150ft. The main span is, therefore, of extraordinarily massive dimensions, and it is believed that it will, in fact, be the heaviest single span in the world.

Dorman, Long and Co. have engaged the services as consulting engineers of Mr. Ralph Freeman, M. Inst. C.E., M. Am. Soc. C.E., of Sir Douglas Fox and Partners, and Mr. G. C. Imbault, and the design and erection scheme have been prepared under their personal direction. The manufacturing programme and the general supervision of the construction project are under the personal direction of Mr. L. Ennis, general manager of the company, who, with Mr. G. C. Imbault, is now in Sydney on the firm's behalf. Whilst the specification requires that certain of the lighter material shall be of Australian origin, it is understood that the greater part of the heavy steel plates will be manufactured in the company's Middlesbrough works. Some years ago the company established constructional yards at Sydney and Melbourne, and the whole of the material required for the bridge will be fabricated, or put together, on the spot in special workshops that are to be built close to the bridge, whilst the construction of the arch will proceed simultaneously from each shore of the harbour.

This contract is of exceptional interest to British engineers, on account of the fact that since the erection of the Forth Bridge, it represents the first single span of first-class magnitude, with the exception of that at Quebec, to be erected in any part of the British Empire.

The Rastricks—Civil Engineers.*

By H. W. DICKINSON and ARTHUR LEE.*

THE aim of this paper is to give some account of a family of engineers who exhibited hereditary ability similar in kind to that of the Stephensons and the Brunels, though lesser in degree.

The family originated in what is now the parish and township of Rastrick—mentioned as Rastric in the Domesday Survey of 1083—in the West Riding of Yorkshire. There there lived from 1651 to 1729 a certain John Rastrick, who in the troublous times of the Revolution of 1688 became impoverished and migrated to Morpeth in Northumberland. His son William (1695–1725) was a millwright at Morpeth, and his grandson John (1738–1826) followed the same occupation. It is with him that our story opens, for he was a man of considerable ability. He was the inventor of the "Imperial barrell churn," which was the earliest churn of any kind to be patented.

The credit of having invented the thrashing machine, usually attributed to Andrew Meikle, was claimed by Rastrick, among others. It is not the place here to go into the early history of the machine. The genesis of Meikle's invention is stated to have been a model which was sent to him by Sir Francis Kinloch of Gilmerton, Bart., who had based his model on a machine he had seen erected by a Mr. Smart in 1772 at Wark, near Morpeth. This model was defective in that the operation was accomplished by rubbing instead of beating. Meikle thereupon experimented with it, and in 1785 succeeded in producing another model with beaters, and in the following year another machine was made that worked exceedingly well. A patent was then applied for and was obtained in 1788.

The evidence that Rastrick constructed the Wark machine is only presumptive, but we have an engraving of Rastrick's machine of unknown date which states that it was invented in 1778. The resemblance between this and Meikle's machine shown in the patent drawing is too close to be accidental.

The earliest record that the authors have found of Rastrick's thrashing machine is in 1790. Particulars of machines that he erected at Brighwellgrove, Oxfordshire, and at Wimbledon, Surrey, are on record.

A trade circular of Rastrick's has been preserved, which, although undated, bears the watermark "1794." Upon this he styles himself "engineer, mill-wright, pump and patent churn maker." He mentions "improved machines for thrashing corn" among work that he executes. He also mentions "Steam Engines on a new Construction." What they were, unless atmospheric engines, we do not know.

A portrait of Rastrick exists, and on the back is a note that: "He conceived and executed a plan from which the stupendous cast iron bridge over the River Wear at Sunderland was made." This remarkable structure was built in 1796 under the patent of Rowland Burdon, September 18th, 1795, No. 2066, who is credited with being both "engineer and paymaster," so what share Rastrick had in the work it is difficult to say; it can only have been a minor one. It is also stated that "he was the inventor of the cylinder as used in flour mills."

John Rastrick appears to have established himself in London in 1798, which goes to show that he was becoming known in his profession. He died at Morpeth on June 8th, 1826, at the advanced age of eighty-eight, and was buried in St. Mary's Parish Churchyard.

John Rastrick married in 1774 Mary Urpeth, of Rothbury, and had three sons and three daughters. His fourth child and eldest son, John Urpeth, was born on January 26th, 1780, at Bullers-green, Morpeth. He received the education of the village school, and if he made any mark at all it was by his liking for mathematics.

At the age of fifteen young Rastrick was apprenticed to his father, and when he was out of his time he made the wise decision to leave home in order to gain experience. He went south, and for a few years worked at Ketley Ironworks, in Shropshire, at that time under the enlightened management of William Reynolds, one of the most up-to-date establishments in the country. In 1807 or 1808 he entered into partnership with, or joined, John Hazeldine, of Bridgnorth, in the latter's foundry business, which had been in existence since 1803, if not earlier. In 1806, Hazeldine was (next to Whitehead, of Manchester) the largest maker of Trevithick engines, judging by a statement of royalties paid to Richard Trevithick and Co. It was in these works that the London Locomotive of 1808 was built. In Rastrick's evidence on the Liverpool and Manchester Railroad Bill in 1825, he said: "About ten or twelve years ago I made one for Mr. Trevithick the person who had the original patent for making it; this was exhibited in London; I did not see that myself. Circular railroad was laid down, and it was stated that this engine was to run against a horse, and that whichever went a sufficient number of miles was to win." It seems quite likely that it was through Trevithick that Rastrick got an introduction to Hazeldine.

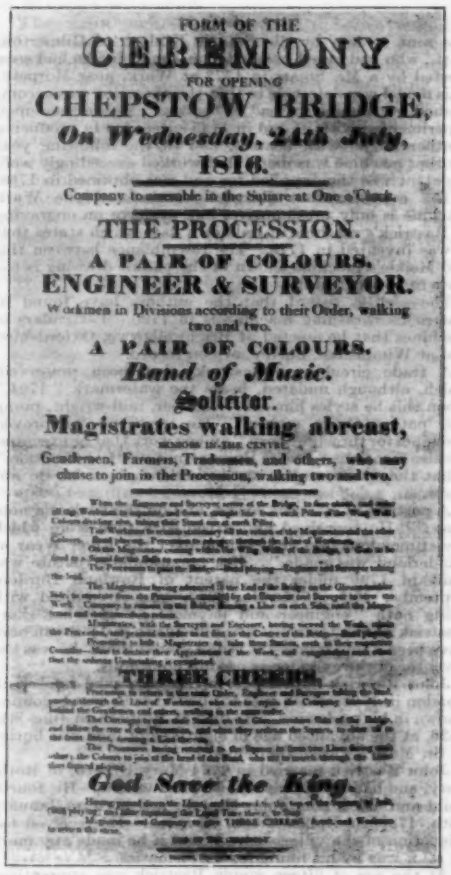
For the next year or two we have no evidence of what Rastrick was doing. All the papers of the firm Hazeldine, Rastrick and Co. have long since been destroyed. Fortunately, we have some portion of Trevithick's correspondence with the firm from 1812 to 1815, owing to the fact that the former's rough draft letter-book covering this period has been preserved. We have also a few letters in 1812 from Rastrick to Simon Goodrich, the assistant of General Bentham, at the Navy Office in London. In one of these letters Rastrick says:—

"I certainly must say that the Engine, and Engine House, Pump Beames, Flywheels, shafts, Spur wheels, Carriages, Training, &c. &c. is as well executed as any work in the Kingdom, and I am sorry it has not been so far finished that we could have it set to work. . . . Trevithick lives within 2 miles of Cambourn and not being at home I went down further to a Mine near Marrixion where I was invited to look at an Engine put up by Woolfe

* Read before the Newcomen Society, March 5th, abridged.

of about ten Horse Power; it was verry well fitted up but extremely complicated and I was told was worked by one third the Coal of B & W Engines—unfortunately it was not at Work when I saw it. I therefore had not an Oppertunity of judging of its Performance; the Piston is on Cartwright's Plan. I have since heard that the Engine has got into discredit and was the Reason of the Order for the Engine I mentioned before being countermanded. I never had any good Oppinion of Woolfe's Engines, for the Complication was in my mind sufficient to condemn them. . . . I went to see an Engine put up by Trevithick, which works with less coal than any Engine I know of. It is a single Power Engine, with an Air Pump and Condensor, only two nozzle valves, but the principal Advantage it has is by working with a Steam of high elastic Power and shutting off the Steam at one-third the Stroke, it expands for the other two-thirds of the Stroke, is then so far lowered in Power as not to exceed the Power of the Atmosphere and of course becomes verry easily condensed. If an Engine is properly calculated, well-executed, and put together, on this Plan I am persuaded it will consume less Coal than any Engine whatever as it can be made so extremely simple. . . . Mr. Davenport informed me that General Bentham had undertaken the Vauxhall Bridge and I have since heard that it is to be made a Compleat Bridge of Iron for 6 Pounds per Ton. If he has I wish him success and should be happy to render him every Assistance that comes within our Power."

This letter shows the means that Rastrick adopted to enlarge his knowledge and widen his experience, not without an eye to business the whole time. The side-



FORM OF THE

CEREMONY

FOR OPENING

CHEPSTOW BRIDGE,

On Wednesday, 24th July,

1816.

Company to assemble in the Square at One o'Clock.

THE PROCESSION.

A PAIR OF COLOURS.

ENGINEER & SURVEYOR.

Workmen in Divisions according to their Order, walking two and two.

A PAIR OF COLOURS.

Band of Music.

Solister.

Magistrates walking abreast,

MESSRS. H. THE CENTRE.

Gentlemen, Farmers, Tradesmen, and others, who may chuse to join in the Procession, walking two and two.

When the Engineer and Surveyor arrive at the Bridge, in their chaise, and after all the Workmen in opposite, and from a straight line from each Pillar of the Wing Wall, Colours drooping, when, taking their Stand, one at each Pillar.

The Workmen in retain stationary till the return of the Magistrates to the other Colours. Band ceases. Procession to advance through the Line of Workmen.

On the Magistrates arriving at the Wing Walls of the Bridge, 3 Guns to be fired to Signal for the Bells to commence ringing.

The Procession to pass the Bridge.—Band playing.—Engineer and Surveyor taking the lead.

The Magistrates having advanced to the End of the Bridge on the Gloucestershire Side, to separate from the Procession, attended by the Engineer and Surveyor to view the Work. Company to remain on the Bridge forming a Line on each Side, until the Magistrates and Gentlemen return.

Magistrates, with the Surveyor and Engineer, having viewed the Work, rejoin the Procession, and proceed in order as at first to the Centre of the Bridge.—Band playing.

Procession to halt. Magistrates to take from Engineer, such as have requested Certificates, time to declare their Approbation of the Work, and congratulate each other that the arduous Undertaking is completed.

THREE CHEERS.

Procession to return to the same Order, Engineer and Surveyor taking the Lead, passing through the Line of Workmen, who are to open the Company immediately behind the Gentlemen and others, walking in the same order.

The Company to take their Stations on the Gloucestershire Side of the Bridge, and follow the rear of the Procession, and when they enclose the Square, to close up in the front Rank, forming a Line the same.

The Procession having returned to the Square in front two Lines deep, each other, the Colours to join at the head of the Band, who are to march through the Lines and there to proceed playing

God Save the King.

Having passed down the Lines, and halted 4 in the top of the Square, the Band ceasing to play, and the Colours having the Royal Pair thereon, the Magistrates and Company to give THREE CHEERS. Artificers and Workmen to return the same.

lights thrown on engineering work that was going on at the time are interesting. The docket on the letter shows that the engine for Mr. Davenport was intended for his copper mill at Swansea. The engine by Woolf near Marazion was, apparently, the first one erected by him in Cornwall, whither he had shortly before returned from London.

The steam engine put up by Trevithick at Wheal Prosper in Gwythian, was a plunger pole engine working with an initial pressure of 100 lb. per square in. In a letter to Rastrick on January 20th, 1813, Trevithick says: "That new engine you saw near the seaside with me is now lifting forty millions 1 foot high with 1 bushel of coal which is very nearly double the duty that is done by any other engine in the country."

The Trevithick engine at this period consisted of a cast iron boiler with a return flue of wrought iron, one leg of which contained the grate, the whole being bolted to the boiler front. The cylinder was sunk in the rear end of the boiler, and connecting-rods from the crosshead returned to a shaft below. In those days of ponderous condensing beam engines, this high-pressure engine was a great advance in lightness and portability. A drawing by Rastrick, upon which he styles himself "Civil engineer" of a "Design for a steam boat," dated March 27th, 1813, has been preserved. It is a paddle boat, or barge, driven by a Trevithick engine. We have proof that nothing came of this design, for Rastrick, in his evidence on the Liverpool and Manchester Railroad Bill, 1825, said: "I have never had anything to do with steam boats." It looks rather as if it was simply one of Trevithick's schemes; the latter certainly toyed with the subject of steam navigation in 1804, and again in 1815. The first was certainly a paddle wheel project, but by the latter date Trevithick had schemed a screw propeller.

On April 1st, 1814 (3799), J. U. Rastrick took out his one and only patent. This was for "a steam engine on a new and improved construction." The patentee says "that the invention need not be particularly described as it will be fully understood on inspecting the Drawing." The latter shows a Trevithick type engine with the cylinder in the boiler. One is led to the conclusion that this patent was merely taken out so that the firm could continue to be able to apply the word "patent" to their engines after the expiration of Trevithick's patent in 1816.

After September 12th, 1815, Trevithick's letters to Rastrick cease after a hectic period of orders and counter orders for the engines destined for Lima. On this ill-fated expedition, Trevithick embarked on October 16th.

As a partner in the firm of Hazeldine, of Bridgnorth, Rastrick's next important employment was to design and construct a cast iron bridge over the Wye at Chepstow, where he had to contend with a tide of 48ft. rise. The centre arch has a span of 112ft., with a rise of 13ft., and the arches on either side are of gradually diminishing spans on the principle known to the Romans for obtaining a graceful effect. The bridge was opened with great ceremony—a programme has been preserved and is exhibited—on July 24th, 1816. The bridge still stands as a testimony to Rastrick's skill. Some difference of opinion arose between the partners over this bridge, but what it was we do not know; at any rate the partnership was dissolved. Consequently, Rastrick went to Stourbridge and joined Mr. W. O. Foster, under the name of Foster, Rastrick and Co. Here he designed and executed plant for many ironworks in the Midlands and South Wales, notably Chillington Iron Works, near Wolverhampton, and Shut End, near Stourbridge. For a year or two we hear nothing of Rastrick, but in 1822 he took a step that was destined to influence his whole future career. He accepted the appointment of engineer to the Stratford and Moreton Rail Road Company, a horse railway of about 16 miles in length between Stratford-on-Avon and Moreton-in-the-Marsh. A MS. note-book still preserved gives estimates, sketches of bridges, &c., the dates ranging from 1822 to 1826. The line is said to have been the first equipped with the continuous wrought iron rails of John Birkinshaw, of Bedlington Iron Works, but this is doubtful.

The construction of the Stockton and Darlington Railway in 1823–25 seems to have stirred engineers deeply, and none seems to have been more alive to its meaning than Rastrick. He was now in his forty-fifth year, well known for his sound judgment and wide experience.

A MS. note-book of Rastrick has been preserved, which shows how varied was his employment. The date is fixed by an entry under the year 1825. Estimates are noted for iron roofs, bridges, gasworks plant, boilers, window frames, sugar pans, pumps and engines. A table of estimates for winding plant for collieries shows the following:—

	10 H.P.	14 H.P.	18 H.P.
	£	£	£
Engine	.. 420 ..	.. 522 ..	.. 612
Winding machinery	.. 125 ..	.. 149 ..	.. 171

An interesting item is a sketch and description of an "oil gas work at Post Office managed by Mr. Currie made by Messrs. Taylor and Martineau of the Citty Road."

Another note is: "Called and saw Mr. Brown's Engine at work at his House at Printing House Square by forming a vacuum by means of the combustion of Gas and atmospheric air." This is followed by a long description. The engine is that patented by Samuel Brown in 1823, and is the earliest real attempt at a gas engine.

It will be proper also to mention here some interesting points that came out in his evidence upon the Liverpool and Manchester Railroad Bill. Rastrick stated that he used a lead rivet—forerunner of the fusible plug—as an effective low-water safeguard in boilers. He also mentioned that it had been the practice, although then disused, to put a single plate of copper in a boiler one-third of the strength of the iron so that the boiler would fail at that point first. The first of these devices is known to be due to Trevithick, and probably the second also is his. Rastrick also mentioned that he always put a lock-up safety valve on his boiler.

Another design was that of the Rastrick boiler for reverberatory furnaces, one of the first waste heat boilers known to the authors. It was of the vertical cylindrical type with an egg-ended top. Midway between the top and the bottom four, or a less number, of side flues led into a central flue communicating with the lower end. The puddling furnaces were arranged radially to the boiler setting. In spite of the fact that the construction was essentially weak and unsuited for a greater pressure than about 25 lb. per square inch, the boiler held its own in the Black Country for more than half a century; indeed, it is not entirely extinct.

In January, 1825, Rastrick, in anticipation of being called as a witness in support of the Liverpool and Manchester Railway Bill, went to Newcastle, where he met George Stephenson, Nicholas Wood, William Cubitt and other engineers. On the 18th the party was at Killingworth, and on the 21st at Hetton Collieries; at both places a number of experiments were made which he detailed under cross-examination. On his way home he visited Middleton Colliery, near Leeds, to see Blenkinsop's rack locomotive, which he mentions having seen two years earlier.

In 1828, Horatio Allen (1802–1889), agent of the Delaware and Hudson Canal Company, arrived in Liverpool from New York to purchase locomotives for use on the railway, 16 miles in length, connecting with the canal at Honesdale, Pa.

Allen ordered one engine from Robert Stephenson and Co., and three from Foster, Rastrick and Co. Why he chose the latter firm one can hardly imagine, because the only locomotive they had made had been the London one of twenty years earlier. Rastrick's design was quite out of date, for, speaking generally, it was a copy of Hedley's "Puffing Billy" class of fourteen years previously. We need not go into detail about these locomotives, because they are dealt with fully elsewhere.

In 1828–29, Rastrick constructed the Shut End Railway from Kingswinford to the Staffordshire and Worcestershire Canal, a distance of 3¼ miles. He also built a locomotive for this line named the Agenoria—a replica of the Stourbridge Lion—with which there was a grand opening ceremony on June 2nd, 1829. The locomotive fulfilled its purpose quite well, as is evidenced by the fact that it remained in use for upwards of thirty years. In 1885 Mr. Job Short reinstated it and Mr. W. O. Foster presented it to the nation; it is preserved in the Science Museum, South Kensington.

As the Liverpool and Manchester Railway approached completion, the directors had to decide what kind of power was to be employed upon it. Needless to relate George Stephenson advocated locomotives, but there was a strong party in favour of fixed engines and rope haulage. No one by this time was in favour of horse haulage, for the difficulties experienced on the Stockton and Darlington line with mixed haulage had been very irritating.

To cut the gordian knot the directors adopted the sensible suggestion of inviting a competition for locomotives which should fulfil certain conditions. Rastrick with Nicholas Wood and John Kennedy were appointed judges. The trial took place at Rainhill with the result that everybody knows.

Rastrick now became deeply immersed in railway engineering, and for the next twenty years there was hardly a line projected or carried through on behalf of which he did not appear professionally either as witness surveyor, or engineer.

In September, 1829, he was engineer for the Kenyon and Leigh Railway, a short junction with the Liverpool and Manchester. The specification has been preserved and is probably the earliest one now extant. He was employed in the following year as contractor to the Leeds and Selby Railway. In 1831 he was engaged with George Stephenson in what was then called the Birmingham and Liverpool Railway. There is a quarto notebook full of his calculations and estimates, with a sketch of alternative routes. This railway was carried out in 1833 as the Grand Junction Railway, after application to Parliament and a lengthened contest.

In these and in every subsequent case Rastrick was an advocate of as direct a line as circumstances would permit.

In 1835 the Manchester and Cheshire Junction Railway was brought forward with Rastrick appointed engineer. This was opposed by the promoters of a rival scheme known as the South Union Railway. The contest led to one of the longest and most expensive Parliamentary fights known up to that date, protracted as it was for over two years. The Act was obtained for the original line under the name of the North Staffordshire Railway and the Trent Valley Railway.

As early as 1836 Rastrick's aid with that of Sir John Rennie was sought by the promoters of a line to Brighton. Here again Rastrick advocated the direct but more difficult route through the downs at Merstham rather than the alternative easy route through the Leatherhead Gap. Together these engineers succeeded in carrying the day. Very heavy work was necessitated in the Merstham, Balcombe and Clayton tunnels. Another big task was the Ouse Viaduct near Cuckfield, a noble structure of 37 brick arches of 30ft. span crossing the river at a maximum elevation of 100ft. These works were carried out by the autumn of 1840. The Brighton, Lewes and Hastings Railway, 1843–4, in which is the well-known Preston Viaduct of 28 arches, together with extensions from Shoreham to Portsmouth and branches to Horsham, Newhaven, East Grinstead and Epsom, were subsequently carried out by Rastrick alone, so that the system known till recently as the London, Brighton and South Coast Railway, executed at a cost of over 2½ million pounds, may be said to be almost entirely a product of Rastrick's brain, and remain as the chief monument to his engineering skill.

Rastrick possessed a vigorous constitution and great determination of character. He applied himself unremittingly early and late to the consideration of the details of his work and wore out his juniors with his energy. They, however, always looked upon him with the feelings of the greatest respect.

He joined the Institution of Civil Engineers in 1827, he became a member of the Society of Arts in 1833, and on January 19th, 1837, he was elected a Fellow of the Royal Society.

Though old age had enfeebled his frame, yet his intellect was unimpaired when he died on November 1st, 1856, in the seventy-seventh year of his age. He lies with two of his sons—Henry and John—appropriately enough in the cemetery at Brighton under a massive granite monument which overlooks the railway. He married Sarah Jervis, of Stourbridge, and had four sons and two daughters. He had a constitutional objection to having his portrait taken, and not even a photograph of him is known to exist.

BAY OF FUNDY ELECTRICAL PROJECTS.

SOME time ago we drew attention to the fact that proposals were on foot for utilising the tidal movements in the Bay of Fundy for the production of electrical energy. Nothing much has been heard recently, in this country, regarding the project, but a report, just to hand, from Moncton, New Brunswick, states that plans have now been prepared for an initial development of 90,000 horse-power at Hopewell, about 20 miles from Moncton, at the junction of the Petitcodiac and Memramcook Rivers. The rise of the ordinary neap tides there is 32ft. We gather that Mr. W. R. Turnbull, of St. John, New Brunswick, who has studied the problem for many years, has suggested that a compartment dam should be constructed across the two rivers near the point of junction, which will make them in effect two reservoirs—high and low level. The Petitcodiac reservoir is to have an effective area of nearly 12 square miles, while the Memramcook, will have an area of just under 2½ square miles. The Petitcodiac is to be the high-level basin, and will be replenished automatically by each succeeding high tide. During each ebb the low-level basin is to be emptied and afterwards filled partly from the waste water of the high-level dam and partly from the tidal waters. According to the report, the turbines are to be so placed in the dams as to give an effective head of water for the generation of power ranging throughout each tidal period from 28ft. 6in. at low tide to 13ft. 6in. at high tide, control being effected by means of a system of gates, or valves, brought into operation at various stages of the tide. So far no further details of the scheme have reached us, saving that the total cost of the initial development of 90,000 horse-power is estimated at 11,000,000 dollars, or, say, 122,500 dollars per horse-power.

Railway Matters.

IN the list of capital works proposed to be carried out by the London, Midland and Scottish Railway Company during the present year there is an entry, "Track circuits, telephones and telegraphs, £36,100."

THE chairman of the Metropolitan Railway states that the "Never-stop" Railway—devised by Mr. Yorath Lewis and described in THE ENGINEER of July 27th last—at the British Empire Exhibition, will be connected with that company's station.

A NEW locomotive, worked by compressed air, was successfully tested in Italy recently on the Roma Nord Railway. The invention is said to consist in an ingenious utilisation of the combined efficiency of hot compressed air and steam, the compressor being driven by a Diesel motor.

THE Metropolitan Railway Company spent on capital account last year £53,082 on a 12,000 kilowatt turbo-generator set, additional boilers, water softening plant, &c.; £13,291 on a new switch house and extension of high-tension switch gear, and £15,094 on a new sub-station. It is proposed to spend £209,200 this year.

THE London, Midland and Scottish Railway Company spent on capital account last year £73,463 on electric train vehicles, £10,210 on manufacturing and repairing works and plant, £6820 on improvements at Ramsden Dock, Barrow, £6300 on an electric coaling crane at Grangemouth Docks, and £46,369 on deepening the inner harbour at Holyhead. On the new hotel and golf course at Gleneagles £246,864 were expended, and on houses and cottages for the company's servants, £163,595.

RAILWAY engineering will suffer a great loss by the resignation of Mr. Roger T. Smith, the electrical engineer to the Great Western Railway. Mr. Smith was concerned in the electrification of the Hammersmith and City Railway, and subsequently joined the Great Western as its electrical engineer. That position now becomes a minor one, as all electrical work will be under the chief mechanical engineer's department, and Mr. J. R. W. Grainge becomes the electrical assistant to the chief mechanical engineer.

THE Lambeth Borough Council has drawn the attention of the London Electric Railway to the "meagre travelling facilities from South London to the City and West End," and has suggested an extension of "tube" facilities to the South and South-East of London—for example, a loop line, linking up at Kennington or the Elephant and Castle with the Edgware and Highgate or Bakerloo railways, and proceeding through Brixton, Streatham, Norbury and Thornton Heath to Croydon, thence *viâ* South Norwood, Penge, Crystal Palace and Camberwell to the points first mentioned.

THE annual report of the Underground Electric Railways Company of London, Limited, sums up the results of the Metropolitan District, London Electric, City and South London, Central London and London General Omnibus companies, all of which it controls. It appears that during 1923 there were on the railways 13,318,629 less ordinary passengers than in the preceding year, 2,180,598 less workmen passenger journeys, and 4,204,050 less season-ticket holders. On the other hand, there were 193,253,049 more passengers carried by the London General Omnibus Company.

A YEAR ago the annual report of the Great Southern and Western Railway Company stated that a provisional agreement towards amalgamation had been made with the Cork, Bandon and South Coast Company. It is now announced that similar agreements have been entered into with the Midland Great Western; Cork and Macroom; and the Cork, Blackrock and Passage Companies at the request of the Free State Government. On the completion of these agreements a joint committee was formed and submitted proposals to the Government for the embodiment of a scheme of amalgamation in a Government measure.

THE Great Northern Railway Company was given power, when the Great Northern, Piccadilly and Brompton Railway was authorised, to veto any tube extension north of Finsbury Park. The Underground railway people say this clause prevents them considering any scheme for an extension of the "Piccadilly Tube," and the London and North-Eastern, which now includes the Great Northern, affirms that a plan must be prepared and submitted before a decision as to a veto can be given. To remove this deadlock the Bill promoted in the present session by the London and North-Eastern Railway is being opposed by the Middlesex members.

THE annual report of the Southern Railway Company remarks that good progress is being made with the electrification work in the metropolitan area of the South-Eastern and Chatham section. Orders have also been given for extensions of the electrified systems in the suburban districts of the Brighton section and of the South-Western section, and the work in the former case is well advanced. It is expected that the 60,000-ton floating dock will be delivered in April. The floating crane, capable of lifting 150 tons, to work in conjunction with it, is now being erected. Orders have been given for the building of five additional steamers, viz., two passenger vessels, two cargo vessels and a paddle steamer; the last is for the service between Portsmouth and the Isle of Wight.

THE Midland Railway Company used to issue a free ticket to the proprietors to attend the shareholders' meetings at Derby, but the annual report of the London, Midland and Scottish Railway Company stated that the directors, after most careful and sympathetic consideration, had arrived at the conclusion that it was undesirable to adopt this practice with the grouped company, as it would be impracticable to provide the necessary accommodation for conveying more than a small percentage of the quarter of a million stockholders who might wish to avail themselves of free travelling facilities for a journey to the general meeting in London. It should be put upon record, as a very interesting fact, that the annual meeting last Friday was held in the Great Hall at Euston Station. The models of engines, sleeping saloons, steamers, &c., were removed, carpets were laid and sound amplifiers provided, so that the chairman's address was clearly heard in all parts of the hall.

Notes and Memoranda.

UNDER their profit-sharing scheme employees of Royles, Limited, Irlam, have just received a higher percentage than paid to the shareholders, the sum distributed representing 8 per cent. of their earnings during the year.

IN the course of a discussion of tarnish-resisting sterling silver by the Sheffield Silver Trade Technical Society, Mr. H. Turner said that the American Government had recently voted 15,000 dollars, and appointed a metallurgical chemist, to institute a research into the tarnishing of silver, the idea being to find further outlets for the large quantities of silver mined in the States.

AT a meeting of the Newcastle and District Association of Foremen Engineers and Draughtsmen, held on March 1st, Captain W. P. Durtnall gave a lecture on "The Generation, Transformation, and Pneumatic Transmission of Power." He is reported to have said that by using compressed air for ship propulsion steam boilers could be eliminated and an economy of from 70 to 80 per cent. effected in fuel consumption.

THE inertia of matter, states a writer in the *Electrical World*, is one of the most important factors entering into engineering calculations. However, the inertia of the human mind is probably even more influential in determining the course of engineering developments. All are familiar with the fact that a practice once established for sound technical reasons often remains in force long after these reasons have ceased to exist. The practice becomes a "policy," and the inertia of the mind resists any tendency to change, frequently causing great delay in the development of industry.

IN deepening the channel of the Columbia River near Walker Island at the mouth of the Cowlitz River, the Port of Portland Commission discovered it could dispose of some 1,235,000 cubic yards of dredged material to a lumber company on the opposite side of the channel. A 30in. pipe was, consequently, sunk right across the bed of the fairway and the spoil delivered in this way, to a distance of nearly 7000ft. A short article in the *Engineering News Record* describes how the pipe was suspended from pontoons, towed into place, and sunk to the bottom.

THE concentrates from Broken Hill, Australia, carry 30 per cent. sulphur, and this must be removed from the concentrates before the zinc can be extracted. The removal involves a roasting process producing a sulphur dioxide gas suitable for the manufacture of sulphuric acid, and the Electrolytic Zinc Company of Australasia is now starting to erect a plant at Risdon for the production of 12,500 tons annually of sulphuric acid, which will then be mixed with approximately 12,500 tons of phosphate rock obtained from the Pacific Islands. The phosphate rock from the Pacific and the acid recovered as a by-product of the zinc works will be combined to produce 25,000 tons of superphosphate.

ACCORDING to Japanese official statistics, 401,902 buildings of all kinds were destroyed in the earthquake, which accounts for the necessity of constructing temporary shelters covered with galvanised sheets. Before the disaster few galvanised sheets were imported, but the imports of black sheets were at the rate of about 200,000 tons a year. The Yohata steel works rolled a number of black sheets, and in Tokio there were 16 galvanising shops, but of these the greater number has been destroyed. Nearly all the orders for new sheets have gone to Britain, but the Japanese Government has bought in the United States 7000 tons of galvanised and 18,000 tons of black sheets, as well as 15,000 tons of nails.

IN his presidential address to the Junior Institution of Engineers, which was recently delivered in London, Sir J. Fortescue Flannery, Bart., dealt with the progress that had been made in the equipment used for marine propulsion during the past fifty years. This equipment included water-tube boilers, the steam turbine, gearing, the Diesel engine, and much electrical apparatus, while another outstanding factor was the increasing employment of oil fuel. Referring to the trials of "La Plata," Sir Fortescue remarked that "her performances on sea service will be watched by all shipowners and marine engineers with absorbing interest and with sympathetic hopes that so much bold, and at the same time scientifically directed, enterprise may meet with the complete success it so richly deserves."

CERTAIN varieties of wood, such as yellow pine and cypress, withstand the action of hydrochloric acid remarkably well, and may be used unprotected in tanks to contain dilute acid. For general use, however, the surface of the wood should be protected from direct contact with the acid, although the demands on the lining are less exacting than is the case with a metal tank. For instance, such a material as asphalt, which is slightly porous and would be inadmissible in the case of iron, forms quite an efficient lining for wood. Many designs of wood tank for acids have been patented and a number of composition linings recommended. In one case a tank is constructed of two layers of wood with the enclosed space filled with a fused mixture of sand, pyrites and sulphur. But the material best adapted for the purpose of a lining is, according to Mr. D. M. Newitt, an acid-proof quality of soft rubber.

THE American Bureau of Standards issued, in March, 1918, its Circular No. 74, entitled "Radio Instruments and Measurements." The demand for this circular has been such as to warrant the preparation of a revised edition, work on which is at present under way. Owing to the rapid growth of radio communication the appliances and methods used have undergone frequent and radical changes. In this growth progress has been made largely through new inventions and applications, and comparatively little attention has been paid to the refinements of measurement. The circular contains information on the more important instruments and measurements actually used in radio work. Many of the subjects with which this circular also deals are, or have been, under investigation in the Bureau's laboratories and are not covered in existing publications. No attempt has been made to deal with the operation of apparatus in sending and receiving.

Miscellanea.

SCHEMES for working the great coal deposits at Fushun by open cast methods are being considered by the South Manchuria Railway.

THE Japanese Government has put up a wireless telephone station with the object of communicating with the trains on the Tokaido Railway while they are in motion.

WE are informed that the Institution of Automobile Engineers is now to be represented on the Main Committee of the British Engineering Standards Association by Mr. H. G. Burford and Dr. T. Blackwood Murray.

THE Chilean Government has introduced a Bill into Congress for the emission of bonds representing 15,000,000 pesos to be devoted to the improvement of present irrigation systems and the construction of additional canals.

THE Brazilian Minister of Transportation and Public Works has granted to the Companhia Radiotelegráfica a concession to install and use four radio-telephone transmitting stations in Sao Paulo, Bello Horizonte, Pernambuco and Bahia.

ELECTRIC wire manufacturing companies in Japan, which were limiting their production 40 per cent. before the earthquake, are now, according to the *Far Eastern Review*, working full time in order to cover the large demand which has been caused by the restoration work in Tokyo and Yokohama.

THE Lourenço Marques Harbour is to be extended for nearly a mile, and the work is to be done in reinforced concrete. When the addition is finished, the harbour will be able to accommodate twenty large steamers or eight liners of the Union-Castle "D" type. The quays are to be provided with eight more electric cranes—seven of 5 tons and one of 10 tons. Moreover, a coal depôt of large proportions is also to be constructed.

THE international competition which had been fixed for March 1st for the construction, upkeep and exploitation of the public works for the water supply of the towns of Athens and Pirsus has been postponed, and will take place at the Greek Ministry of Communications in Athens on June 1st. Full particulars may be obtained at the Greek Legation, 51, Upper Brook-street, London, W. 1, between the hours of 12 and 1 p.m. and 3.30 and 5 p.m.

IT is announced that the Hull (Quebec) Electric Company will proceed this spring with its big project in the Gatineau Valley, according to which a power plant will be erected at Paugan Falls in the township of Low, with an eventual capacity of 100,000 horse-power. The necessary lands on both sides of the Gatineau River were purchased a year ago; the falls and river have been surveyed, and the site mapped out for the dam which is to be constructed.

THE Vancouver Board of Harbour Commissioners has just announced that the port is to have coal bunkering facilities for deep-sea vessels almost immediately. Temporary means for providing the bunkers will be instituted at once, and as soon as trade warrants permanent coal bunkers will be erected. The Board has stated that it is willing to spend up to 500,000 dollars for bunkers, if warranted, and it is understood that it proposes to submit to the Federal Government plans for an additional expenditure of 5,000,000 dollars for the development of the port. The present appropriations amount to 10,000,000 dollars.

BUILDING activities in Argentina continue on an unparalleled scale. The demand for all classes of building supplies, including hardware, sanitary equipment, and general construction materials, cannot be met, and rush orders are being sent abroad for further supplies. Builders' hardware received from Germany is said to have proved of such inferior quality that it has lost ground in the market. Building permits during 1923 in Buenos Aires alone averaged over 2000 per month, compared with fewer than 500 per month in the period between 1914 and 1920, the total reaching 20 per cent. more than in the boom year of 1910.

ACCORDING to a message from Toronto Lieut.-Colonel A. E. Dubuc, of Montreal, who, since the war, has been Superintending Engineer of the Quebec Canals, has been appointed Acting Chief Engineer of the Department of Railways and Canals in succession to the late Mr. W. A. Bowden. Lieut.-Colonel Dubuc performed valuable services in canal work prior to the war, in which he went overseas and won rapid promotion, being awarded the D.S.O. On his return he was appointed Superintending Engineer of the Quebec Canals. His latest appointment, so shortly after the death of Mr. Bowden, is due to the desire of the Government to have an experienced administrative head of the engineering branch of the Railway and Canals Department to take up the work of his predecessor as a member of the Engineering Board of the International Joint Commission in connection with the St. Lawrence River project.

SPEAKING at the annual meeting of the shareholders in the Manchester Ship Canal on Thursday, 28th ult., Mr. W. C. Bacon, the chairman, referred to the recent strike of dock labourers. He said that at the time when the advance of wages was first formulated, the canal directors were of opinion that an increase was not due in the district. The minimum rate of wages earned by dock workers at Manchester was 125 per cent. over pre-war rates; the cost of living, according to the index published by the Ministry of Labour, being stated to be no more than 75 per cent. above 1914—*i.e.*, pre-war cost. Work was plentiful at the docks, and the registered casual dock workers were employed, on the average, five days per week, counting work done in overtime hours; sometimes there was a shortage of men. Considerable overtime was necessary, but the men would only consent to work a limited time—namely, 3 hours each day from Monday to Friday. When it was considered that the docker's week was 44 hours, plus at Manchester all the extra hours the men consented to work—namely, 15—a dock worker could not possibly be employed more than 59 hours per week, with an earning power at the lowest-paid rate of £4 3s. 1½d.

THE TWIN-SCREW MOTOR YACHT SEA KING

THE NOVA SCOTIA STEEL AND COAL COMPANY, LIMITED, NEW GLASGOW, BUILDERS

(*For description see page 246.*)

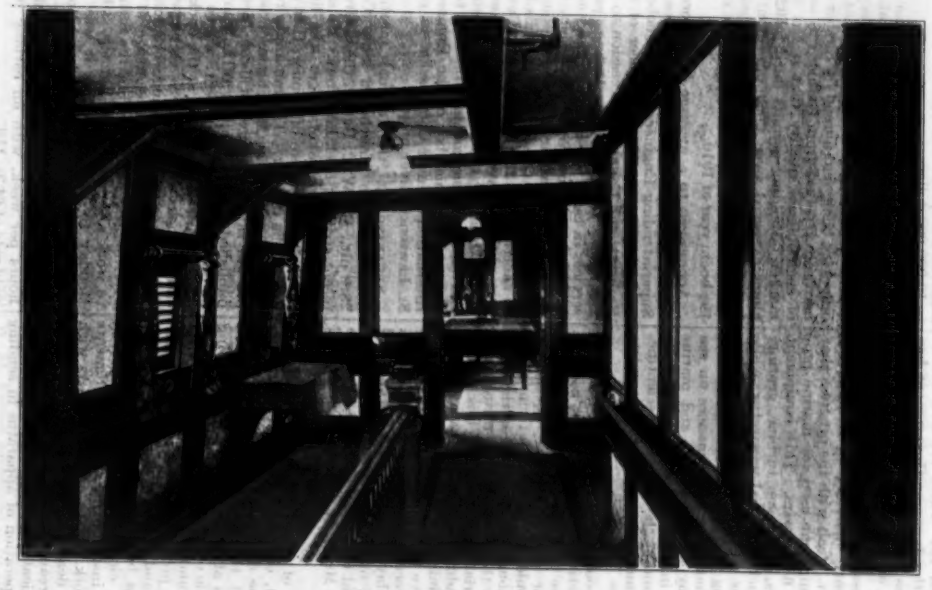


FIG. 4—VESTIBULE ENTRANCE

FIG. 5—OWNER'S CABIN

FIG. 6—OWNER'S STUDY

FIG. 7—MAIN SALOON

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Postal Address, 35, Norfolk-street, Strand, W.C. 2.
Teleg. Address, "Engineer Newspaper, Estrand, London."
Telephone Nos. 2256, 2257 Central.

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*** *With this week's number is issued as a Supplement a Two-page Plate illustrating the Twin-screw Motor Yacht Sea King. Every number, as issued by the Publisher, contains a copy of this Supplement, and Subscribers are requested to notify the fact should they not receive it.*

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By arrangement with Reuter's Engineering Service, The Engineer *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

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Supplement—The Twin-screw Motor Yacht Sea King.

DEATHS.

On February 27th, at "Pescot," Longfield, Kent, James Murray Dobson, M. Inst. C.E., aged 77.

On Monday, the 3rd March, at 87, Victoria-street, S.W., Oliver Claude Robson, M. Inst. C.E., age seventy-five, for nearly fifty years engineer to the Willesden District Council.

THE ENGINEER.

MARCH 7, 1924.

The Work-Hardening of Metals.

Although the phenomenon exhibited by most metals of hardening when worked in the cold state is scientifically of great interest, no completely satisfactory explanation of its cause has yet been advanced. In spite, too, of the fact that the phenomenon is of much moment in practice—particularly in the wire-drawing and deep-stamping industries—there is no familiar means of measuring, readily and accurately, the extent to which it has been developed in a sample of cold-worked metal. Still less satisfactorily can we determine beforehand the work-hardening tendency of a given specimen of normal material. As regards the cause of work-hardening, the researches of Sir George Beilby and others are held by some to provide at least a partial explanation. Beilby, it may be recalled, showed that when a metal is subjected to stress above the elastic limit, the crystalline structure is, in part, changed to a non-crystalline one. Ewing, and others subsequently, found, under the microscope, that the changed metal was formed on gliding surfaces within the crystalline grains. If it be supposed that the changed metal behaves like a rigid vitreous substance, the phenomenon of work-hardening becomes fairly understandable, for cold working necessarily involves the application to the metal of stresses exceeding the elastic limit and must, therefore, be accompanied by the development of the vitreous state. On the other hand, the accepted explanation of the permanent ductile strain which occurs in metals after the yield point is reached, seems to require that the changed metal should behave not at all like a rigid vitreous substance, but as a viscous liquid. According to Professor Haigh, of the Royal Naval College, Greenwich, with whose latest investigations on the subject we hope to deal in the near future, these two requirements as to the nature of the changed metal are not necessarily incompatible. On thermodynamic grounds he has worked out a basis of reconciliation. But the fact that reconciliation of any kind has to be sought is evidence of the uncertainty of our knowledge regarding the cause of work-hardening in metals. As to its measurement, it seems to be established that an indentation test of the Brinell type fails in general to give a true indication of the additional hardness produced in a metal by cold-working. Such a test may, in fact, show no change, whereas the subsequent behaviour of the metal at the draw bench, or press, may reveal a change so great as to render further work on the material impossible without thermal treatment. If it is unsatisfactory in this respect, still less satisfactory is the ordinary indentation hardness test as a means of determining at the outset of the operation whether, and if so, to what extent, and with what rapidity, the metal will harden under the subsequent cold-working.

From our first acquaintanceship with the pendulum hardness testing device invented by Mr. E. G. Herbert, of Manchester—see The Engineer, April 13th, 1923—we have regarded it as an instrument of great scientific interest and promise. It seemed to provide a key to the opening of many doors, leading to an extension of our knowledge regarding not only the phenomenon of hardness in general, but many other important properties and characteristics of materials. That view is amply justified by the facts and figures revealed in an article published elsewhere in this issue, and would be still further emphasised were we at liberty to mention still more recent results which Mr. Herbert has obtained with his tester in an entirely new direction. Devised, in the first instance, simply as an alternative to the Brinell, scleroscope, and other familiar forms of hardness testing devices, the pendulum instrument, it is now obvious, yields results, under certain conditions of working, which extend its range of usefulness considerably beyond the determination of hardness. It owes its inception wholly to practical intuition and reasoning, and not at all to mathematical theorising. Even yet the theory of the device is very far from established. Mr. Herbert hesitates to dogmatise as to the reasons for its action even under the simplest conditions—those of the "time" test. Applied under other conditions, it yields strongly marked data, the interpretation of which is still far from certain. In the case of the results recorded in the article on page 248, there can, however, be little or no doubt as to their meaning. Operated in accordance with the conditions of the "time" test, the device, like the Brinell and other indentation hardness testing instruments, fails substantially to reveal any difference in the properties of steel plate subjected to varying amounts of cold rolling. But operated in accordance with the conditions of the scale test, it gives a series of figures which is clearly a reflection of the amount of cold rolling to which the specimens were subjected. That the scale test figures are an indication of the work-hardness developed in the specimens by the rolling is logically confirmed by the results obtained from two specimens of deep-stamping steel. The two specimens, otherwise identical, were found, in practice, to give good and poor results respectively. They yielded closely similar time test figures, but the scale test figure for the poor steel was more than four times as great as that for the good steel. Having obtained this strong, if not conclusive, evidence that the scale test was capable of measuring work-hardness in a cold-worked material, Mr. Herbert proceeded to devise a simple method of operation to enable him to determine beforehand the work-hardening tendency of any specimen of normal material. By making repeated scale tests on the one spot on the surface of the specimen, he caused the pendulum tester itself to perform the cold-working, and by noting the scale readings at the end of each "pass" he was enabled to observe both the magnitude of the work-hardness and the rate at which it was produced. Except for certain minor, but, nevertheless, interesting irregularities, the results obtained were entirely in keeping with known facts concerning the work-hardening tendencies of the materials tested. In addition, several indications of a novel kind were obtained, chief among which was the demonstration of the part played by a coating of tin in protecting steel sheet from work-hardening influences. Supplementary to the information given elsewhere, we may here record certain facts which will, we believe, in a short time provide convincing evidence as to the ability of the instrument to measure the work-hardening tendency of metals. Mr. Herbert recently received from the United States a dozen or more samples of tin, or tin alloy, in the form of small cast ingots. He was informed that while certain of the samples could readily be rolled into tinfoil, others behaved badly under the process, although there was not more than

one-tenth of 1 per cent. difference in their chemical analysis. On testing them by the repeated scale test method, Mr. Herbert found that while all the specimens had substantially the same initial hardness, they exhibited on the second and succeeding passes an increasing and very strongly marked tendency to separate out into two classes, one characterised by the development of considerable work-hardness, the other by the development of little or none. He has yet to hear whether the two classes as determined by his tests correspond with the two classes as determined by workshop experience. Even should they differ the interest in the pendulum tester will not be destroyed, but merely transferred to new ground, for if the definite difference between the two classes under test does not indicate a difference in their work-hardening qualities, it must imply some other emphatic difference the nature of which demands discovery.

If, as seems reasonably certain, the pendulum scale test and its modification provide means for the measurement of work-hardness and work-hardening tendency, the opportunity would appear to be opened up for a scientific investigation into the nature and underlying cause of work-hardness and how it may be controlled. That field has, so far, been explored with little practical result. The mathematicians have almost wholly neglected it. Their investigations are based on the assumption that Hooke's law is obeyed throughout and their results are applicable to practice, if they are applicable at all, only to the range of stress below the elastic limit. Hardness, as a consequence, falls outside their field, for hardness is, in very large measure, an aspect of the behaviour of a metal above its yield point. Work-hardening is still farther beyond the ambit of the mathematical elastician, for it would appear to be associated wholly with the region of non-elastic strain. Until the mathematical plastician arises, the experimental method alone is available to us for its investigation, and to that end the pendulum tester appears to be a highly promising instrument. Many questions must, however, be asked and answered before even it will yield the knowledge we desire. We know, for instance, from recent researches on boundary lubrication, that extreme precautions are requisite to secure unlubricated metallic contact. No such precautions are observed when a pendulum hardness test is made in the usual way. Yet, from the apparently protective action of a film of tin on steel we would be disposed to suspect that the work-hardening effect must be influenced by the state of cleanliness of the surfaces of the specimen and ball. We understand, however, that this point has not escaped Mr. Herbert's attention—indeed, that he has closely investigated it and has come, tentatively, to the conclusion that the state of lubrication of the surfaces does not affect the readings of his instrument. Again, the question must arise as to the relative values of the hardness figures yielded by the device and, in particular, whether a metal hardened by work to, say, 50 points is as hard in all respects as a normal metal having a scale hardness of 50 in the unworked state. The investigation of this point, it seems to us, demands attention, for the results should enable us to form an opinion as to whether hardness produced by work is really exactly the same property as the hardness normal and proper to metals. At present there are no grounds for believing definitely that it is. On the contrary, there are both theoretical and experimental indications that work-hardness and work-hardening tendency are, at least distantly, related to the phenomena of hysteresis and fatigue.

Extrusion.

The extrusion process is one of the most attractive developments of modern metallurgical practice. A suitably heated billet of metal is placed in a heavy container and pressure is applied by means of the ram of a powerful hydraulic press; under this pressure the metal flows out through the orifices of a die placed in the end of the container, in the form of a rod or bar or with almost any desired cross-section. It is an ideally simple operation as compared with the older processes which involved rolling and drawing, whether hot or cold, sometimes complicated by annealing or re-heating operations. The extrusion press itself is, of course, a heavy and costly piece of machinery, but these drawbacks are more than counterbalanced by the saving in the cost of production, even apart from the fact that it is possible to extrude both materials and sections which could not be obtained by any other means. It is not surprising to find that so useful and attractive a process has come into wide use, and there can be no doubt that extruded metal to-day holds a definite and unassailable place among our metal products. Actually, there is a desire on the part of some manufacturers, at all events, to substitute extrusion for rolling as completely as possible, and it is at this point that we think it necessary to sound a word of caution.

Under the pressure of war conditions, extruded metal played an important and valuable part in meeting the heavy demands for brass rod suitable for the production, particularly, of fuses, But, although the demand was met in this way, all those who were in any way concerned with this matter are well aware that difficulties were encountered, and that considerable quantities of extruded bar had to be rejected as entirely unfit for use. The defects met with in this material are of a special and peculiar type, so much so that in some quarters they have come to be known as "The extrusion defect." Whether the sweeping generalisation implied in such a term—that there is only one type of defect in extruded material—is entirely justified, is open to question, but the type of defect referred to is well known. It consists of a longitudinal unsoundness or discontinuity affecting the inner portions of a bar, sometimes confined to a few inches from one end and sometimes running through the whole length of a bar, although, of course, there are many extruded bars entirely free from it. In its cruder forms such a defect is readily detected, but the trouble comes with those cases where the defect is sufficiently slight to escape observation or even to allow the bar to be machined, while yet sufficiently serious to cause considerable risk of failure in subsequent service. Up to a certain point, the soundness of any bar can be tested by a simple fracture test; a test made by bending a notched length of the bar readily reveals longitudinal unsoundness by yielding a "fibrous" fracture, and it is a simple but necessary precaution to apply such a test to both ends of every extruded bar. Sometimes such a test reveals unsoundness at one end, which is bound to continue on repeating the test for several feet down the length of the bar, and then the fracture becomes perfectly sound. In such cases it is assumed that the rest of the bar is sound and, as a rule, it is—but there can be no real certainty about it. From the viewpoint of the engineer who is invited to use extruded metal for purposes where strength and reliability are essential, it is most important to know the true cause and nature of these defects. This knowledge is important, not only because it is necessary for the manufacturer in order that he may eliminate or at least minimise the occurrence of the defect, but also that the engineer may know what he must guard against and how far he may rely upon the material after a given set of tests have been applied. Unfortunately, opinion of scientific and practical metallurgists is not entirely unanimous as to the true nature and cause of extrusion defects. The Research Department of the Royal Arsenal at Woolwich, after prolonged experience and a good deal of experimental investigation, has come to the conclusion that the internal unsoundness results from the peculiar flow which occurs in the container from which the metal is forced, and that, as a result, some portions of the original external skin of the billet, both from its sides and end, are pushed into the central parts of the bar, particularly near the tail end, and there seems to be no room to doubt that this action can and does occur. On the other hand, metallurgists at the National Physical Laboratory have traced the same type of defect to unsoundness of the original ingot into which the metal is cast, and their evidence also is very strong. Fortunately, this latter source of trouble is comparatively easy to eliminate, as it is perfectly possible to cast sound ingots of most of the alloys used for extrusion. The drawing-in of skin, however, is a much more difficult problem.

In view of the importance of these matters, one would have thought and hoped that manufacturers of extruded metal would have shown keen interest in investigations of this kind. Actually, when papers on these subjects were presented some two years ago to the Institute of Metals, none of the manufacturers interested took any part in the discussion, and so unanimous was this attitude that it suggested a desire on their part to avoid discussion of an unpleasant subject. It is difficult to believe, however, that such an ostrich-like attitude could be seriously adopted. The existence of the defect is only too well known, and at present undoubtedly militates against the use of extruded metal on the same basis as that rolled or drawn. The real hope of the manufacturer desirous of pushing this product is to have the causes and nature of these defects thoroughly cleared up. Even if an individual manufacturer investigates the matter and arrives at a solution, unless this solution is published and submitted to free discussion and criticism, he will gain very little. His mere affirmation that *his* extruded metal is free from the defect is not likely to be readily accepted until it is borne out by prolonged experience, and if, in the course of his manufacture, only a very small proportion of defective material is produced, it is very likely to find him out and to discredit his statement quite disproportionately. Such a matter must be dealt with in an entirely open and above-board manner if confidence is to be established. In the interests of an eminently desirable process and product, it is important that full knowledge, and the confidence it brings with it, should be obtained as soon as possible.

Engineering in Literature.

On Monday last Lieut.-Colonel E. Kitson Clark delivered the annual lecture to the London graduates of the Institution of Mechanical Engineers. The subject was "Engineering in Literature," and the sustained applause with which it was received was not, we think, only a well-deserved tribute to the lecturer, but showed that engineers not less than other men appreciate literature.

Opening his lecture with a brief reference to the demand of the Institution that "those who desire the privilege of membership must pass beyond the study of the specialised functions of their profession," Lieut.-Colonel Kitson Clark asked: "If, then, the engineer is expected to take an interest in Literature, we are incited to ask, What interest Literature has taken in the engineer?" Then, seeking for a definition of literature, the lecturer said:—

"In a certain technical work, an accident at sea is described with an explanatory diagram. Owing to the fracture of the connecting-rod bolts, 'the piston with its rods and the connection of the forward engine had made a violent up-stroke, breaking several of the studs securing the cylinder cover, and starting them all. The steam had then been admitted on to the top side of the piston, causing it to make a down-stroke with greater violence still, the result being that the foot of the connecting-rod (C) struck the starboard cast iron column of forward engine, completely severing it at the foot, and displacing it, as shown at (D). It was also cracked half round at (E), and started at the top (F), the bolts next the centre line of Engine being broken. While the connecting-rod was in the position shown, the crank of its engine was brought round by the aft engine, and struck the rod as shown at (G), bending the latter in two directions and also bending the piston-rod crosshead as shown at (H), causing the guide shoes to be immoveably jammed between the guides, which no doubt caused in some measure the displacement of the starboard column, and the fracture in four places of the port or condenser columns (I).'

"And here is the story touched by a master hand: 'What follows is worth consideration. The forward engine had no more work to do. Its released piston-rod, therefore, drove up fiercely, with nothing to check it, and started most of the nuts of the cylinder-cover. It came down again, the full weight of the steam behind it, and the foot of the disconnected connecting-rod, useless as the leg of a man with a sprained ankle, flung out to the right and struck the starboard, or right-hand, cast-iron supporting-column of the forward engine, cracking it clean through about six-inches above the base, and wedging the upper portion outwards three inches towards the ship's side. There the connecting-rod jammed. Meantime, the after engine, being as yet unembarrassed, went on with its work, and in so doing brought round at its next revolution the crank of the forward engine, which smote the already jammed connecting-rod, bending it, and therewith the piston rod crosshead—the big cross-piece that slides up and down so smoothly.

"'There being nothing more that could be made to move, the engines brought up, all standing, with a hiccup that seemed to lift the Haliotis a foot out of the water; and the engine-room staff, opening every steam outlet that they could find in the confusion, arrived on deck somewhat scalded but calm. There was a sound below of things happening—a rushing, clicking, purring, grunting, rattling noise that did not last for more than a minute. It was the machinery adjusting itself, on the spur of the moment, to a hundred altered conditions.'

"The first of these two accounts (from a well-known Handbook) is a straightforward story for the technical reader. The second (from Kipling) is truly an epic to put into any man's hand, and from the contrast there emerges a definition of literature which I think may serve our purpose. The layman is to be the testing ground, and his interest the proof. Touch the incidents and facts of engineering with imagination, use them as illustrations, you are not far from Literature, and the layman will find it out for you. Yet it was long before the writers found a value in the acts of our profession, although in the course of things that men have done, mechanical achievements have been perhaps the most potent influence in their progress. The instruments of life, the stone, bronze, iron implements in succession, gave growing efficiency to men in their tillage, their fights, their housing, their journeys, and their trade. We cannot but suppose, therefore, that neolithic conversations would turn on the merits of one scraper against another, and that bronze age gossip would report far and wide a new process by which metals were cast or forged. But these subjects did not at first come into Literature. It is true that dignified echoes reach us from the voiceless period of pre-history, such as in the verse of Genesis iv. 22. 'Tubal-Cain, an instructor of every artificer in brass and iron,' or in Æschylus' drama of Prometheus banished for his revolutionary gift of fire to men. These are only echoes; they compel, indeed, the attention of all sorts and conditions of men—the one for the interest of the record, the other for its great gesture and magnificent language. But there is not in them the conscious use of the engineering element for Literature. Nature, of course, was the first source of imagery. The earliest *metaphor* that I find in the Bible is: 'I will send a faintness into their hearts in the hands of their enemies, and the sound *of a shaken leaf* shall chase them.'* The second is in Deuteronomy: 'The Lord thy God is he which goeth before thee; as a consuming fire he shall destroy them.'†

"Engineering achievements must have already taken form, but at the outset they are unrecorded, and when later on they came to be described, there is a narrative value rather than literary intention in the accounts. The great enterprises of the Ark and the Tower of Babel are treated in chapters which read like specifications, presenting points of interest rather for the expert than for the layman."

The lecturer then showed by further examples from the earlier books of the Old Testament that such references to engineering as diligent search had revealed, seemed "to come into the pages rather to set the stage than to add literary value to the narrative. Later on, however, it came about that man's technique, or production by hand, or brain, were brought into the text as general metaphor, and therefore, according to my definition of Literature, and when this came about they brought with them at once a new value and a noticeable vigour." Telling passages from Proverbs and Job were quoted to sustain the argument. That from Job begins "Surely there is a vein for silver and a place for gold where they fine it."

Passing from the Bible, "the greatest element of literature common to us Anglo-Saxons," Col. Kitson Clark put Greek and Roman authors to the test and found their references to engineering outside his definition of Literature. We take the following passage from the lecture:—

"Velleius Paterculus‡ cried out there was no new subject. He held that Literature is subject to the universal laws of growth, consummation and decay. Something new was required, but the craving for novelty he found was a hindrance to perfection. So Literature was dead, and yet we know there were before any author who had eyes to see the great engineering works of man, that magnificent province of Roman genius. Do *we* not see great prose and fine poetry in their seaborne commerce of the world; in the massive brick arches of Rome; in their network of great roads across the Empire, their stern bulwarks traced well-nigh from the west coast of Northern Britain to the shore of the Black Sea. This was great material indeed, but it appeared to be nothing to Roman orators, essayists and poets in the generality, for we must except Pliny§, who wrote that no work in the world, however magnificent, could be compared to the aqueducts."

Coming to "our own tongue," the lecturer said:—

"There are phrases to be found in Shakespeare, but these I leave as an enjoyable subject of research for young engineers, and leaving those spacious days, I spring to the age of invention and mechanical development. The nineteenth century should surely have recognised the poetry and romance of the growing giant Engineering; but Literature was cold. Turner indeed gave us a magnificent mist in his picture of the Great Western locomotive, "Steam, Wind and Rain." But later, when material progress had reached her throne in a great palace all of crystal, and Tennyson pronounced its blessing, that blessing was no great matter"—as Lieut.-Colonel Kitson Clark proceeded to demonstrate by a quotation from an Ode sung at the opening of the International Exhibition.

In Samuel Butler's "Erewhon," the lecturer found more literature within his definition, and quoted those well-known passages in which the danger of the world becoming "mechanised" are set forth, and in which the complete destruction of all the machines in Erewhon is decreed. Continuing, he said:—

"Here, in Storey's Gate, in this Temple of our Goddess Mechanica, from this dais where her high priests do assemble at the greater festivals, the creed of Samuel Butler or the litany of Videk can hardly be preached. But many would approve a hymn of like heresy which we owed a few years ago to the genial irony of J. K. Stephen. One stanza suffices. It is in his 'Lamentation on the Insufficiency of Steam Locomotion in the Lake District.'

"Wake, England, Wake! 'Tis now the hour
To sweep away this black disgrace—
The want of locomotive power
In so enjoyable a place.
Nature has done her part, and why
Is mightier man in his to fail?
I want to hear the porters cry,
'Change here for Ennerdale!'

"Ruskin, we must remember, did not speak very highly of the railroad, and in our day Gordon Bottomley addressed to 'Ironfounders and Others' lines which are not altogether appreciative of their art:—

"When you destroy a blade of grass,
You poison England at her roots.
Remember, no man's foot can pass
Where evermore no green life shoots.

. . . . .

"You have brought down the firmament,
And yet no heaven is more near,
You shape huge deeds without event,
And half-made men believe and fear.

while Harold Munro drew one of our most modern triumphs in a somewhat humbled state:—

"THE FOUNDERED TRAM.

"There it lies
An injured toad,
Tumbled away to the side of the road,
Dashed from the track of its shiny slime;
Silly sight for passing eyes;
Skeptic of the rules of time
Where has it thrown its respectable load?"
&c. &c.

By these steps the lecturer came to Kipling, who "has stirred in us something that others have not touched before—has written for us words that translate this technical subject into stores of delight to expert and laymen alike. The romance of locomotive No. .007, the birth of a steamship come into being, the Hymn of McAndrew, are literature indeed, radium till then unsuspected in a prosaic mine."

Then, after a few more quotations, Lieut.-Colonel Kitson Clark ended a lecture, which had held his audience delighted throughout, in this peroration:—

"I have stocked my paper with quotations; indeed, they are my paper, but they will not be carried further by me. I am not without hopes, however, that some present here may find a pleasure in the quest which I have enjoyed. If they have the spirit of an encyclopædist, if they schedule all metaphors, and list all the similes that they find, I think they will almost dare to say that literature in general tends to seek the conventional for its images, and even for its subjects. They may find that though handicraftsmanship has appealed to the writer and speaker, yet the more difficult achievements of tool and invention and administration have not generally attracted literary interpretation. There may be reasons why our profession has not provoked the literary art, not indeed in such a way as to interest the non-expert. One could have imagined that the obedient courses of a canal, the glory of a great arch, the cunning of a pully system, the steadfast majesty of a pyramid, might inspire a writer. But we have bare records of these things and no more. It would not be easy perhaps to find an expression of a love poem in a mechanical device; it might be difficult to associate a heroic friendship with machine work. I could hardly imagine a David congratulating Jonathan on the balance of their mutual reciprocating action. I cannot think of a lover singing of the streamline form of his heart's desire. "Organisation" is a blessed word, but it has not yet found its way into serious verse, for reasons beyond its rhyming and scanning disabilities. I need not lengthen absurdities of this kind. For to sum up, I fear that we as a profession are somewhat dissociated from this Literature, this great part of the criticism of human life. I hope it is not inevitable. I hope that if Literature is in the prologue of the education of an engineer, we may take care that we recognise it, and that where we can we may give it cause to recognise us.

"And while I exhort you to this, I confess, in due humility, that it is but ill-defined. What is Literature? My own description is not of universal application. I must have laymen upon whom to apply the test of interest; but in affairs of emotion, anger, admiration, fear, love, we are all experts. There are no laymen whom we can bring to the touchstone, and still we have no doubt of the claims of certain writing on these matters to the full title. Therefore, I will keep my definition to the cause of special-subject men—chemists, bookies, mathematicians, upholsterers, poultry-keepers, metaphysicians, solicitors, politicians, and, higher still, engineers—and very little, we find, has Literature to say about the engineer, at any rate. After all this talk, then, the question remains, What is this Literature, and why are these things so? I have the honour to leave these matters to you, gentlemen."

* Leviticus ix. 3.
† Deuteronomy xxvi. 36.
‡ B.C. 19 to A.D. 30.
§ Pliny, Nat. Hist., XXXVI. 24.

Obituary.

WILHELM SCHMIDT.

ON February 16th, after a long and painful illness, there died at Bethel, near Bielefeld, Wilhelm Schmidt, the founder of the Schmidt Heissdampf Gesellschaft in Cassel. Wilhelm Schmidt was self-educated. He was born on February 18th, 1858, at Wegeleben, near Halberstadt, the only son of simple agricultural people. His inclination towards technical matters was manifest in his early youth, and through the influence of friends he entered the Dresden Technical High School, under that famous professor, Dr. Zeuner.

When he was scarcely twenty-five years of age he established himself independently in Brunswick and made it his life's work to improve heat engines. One of his first schemes was to design a small engine, for the electric motor was not then known. In the course of that work he hit upon the idea of driving engines with a mixture of hot air and steam, and finally of driving steam engines with superheated steam alone. The first experiments, which lasted for eight months in the year 1891, were conducted in Cassel at the works of Beck and Henckel, and resulted in Schmidt transferring himself to Wilhelmhöhe, as Director Henckel, who had become his fast friend, had promised him his further assistance in carrying out his work. Step by step the familiar form of Schmidt superheater was evolved, and it rapidly took a place of the first importance in locomotive and marine engineering.

It is reported that more than 100,000 locomotives in all parts of the world are to-day driven with superheated steam, and that there are already more than 2500 vessels equipped with Schmidt superheaters. The last twelve years of Schmidt's efforts were occupied with the production of steam pressures of 60 and more atmospheres. As a young man, in 1885, he had already begun work on this task, but after spending several years on it he had to give up, because at that time neither he nor the technical means available were yet sufficiently advanced for the solution of the problem. The first announcement of the success of the labours and experiments of Wilhelm Schmidt with high-pressure steam was made at the general meeting of the Union of German Engineers at Cassel in June, 1921. The remarkably low steam consumption figure of about 2½ kilos. per indicated horse-power hour which was obtained with a 150 horse-power steam engine excited, when made known, enormous interest, both at home and abroad, for it proved that the increase in steam pressure, which had been regarded by both science and practice as undesirable, had been looked at in the wrong light.

BOOKS RECEIVED.

The Motor Electrical Manual. Second edition. London: The Temple Press, Limited, 7–15, Rosebery-avenue, E.C. 1. Price 2s. 6d. net.

Elements of Radio Communication. By E. W. Stone. London: Crosby Lockwood and Son, Stationers' Hall-court, E.C. 4. Price 15s. net.

A Course of Experimental Mechanics. By H. J. E. Bailey. London: Chapman and Hall, Limited, 11, Henrietta-street, W.C. 2. Price 7s. 6d. net.

The Book of the Ford Electrical Equipment. By R. T. Nicholson. London: Temple Press, Limited, 7–15, Rosebery-avenue, E.C. 1. Price 2s. 6d. net.

Terremoto e fondazioni asismiche. (Reprinted from *Ingegneria*, January 1st, 1924.) By Ing. Mario Viscardini. Milan: Stabilimento Tipografico Stucchi Ceretti (Soc. An.), 16, Via S. Damiano 16. 1924.

Merchant Ship Types. A Survey of the Various Units Engaged in the Water Transport of People and Merchandise. By A. C. Hardy. With a Foreword by Professor J. J. Welch. London: Chapman and Hall, Limited, 11, Henrietta-street, Covent Garden, W.C. 2. Price 15s. net.

Institution of Civil Engineers: Minutes of Proceedings Vol. ccxv. and Vol. ccxvi., being Parts I. and II. of session 1922–23. Edited by Dr. H. H. Jeffcott, Assoc. M. Inst. C.E., the secretary of the Institution. London: The Institution of Civil Engineers, Great George-street, Westminster, S.W. 1. 1923.

Institution of Civil Engineers: Selected Engineering Papers:—No. I, "The Deflections of Suspension Bridges," by John Wyatt Spiller, M. Inst. C.E.; No. II., "The Experimental Development of an Automatic Integrating 'Intensity' Rain Gauge Without Clockwork," by John Willoughby Meares, M. Inst. C.E.; No. III., "A New Method for the Improvement of Existing Railway Curves," by William Hamilton Shortt, Assoc. M. Inst. C.E.; No. IV., "The Estimation of Storm-water Discharge from Inhabited Areas," by Dr. George Stephen Coleman, Assoc. M. Inst. C.E.; No. V., "The Mechanical Screening of Circulating Water and of Sewage," by Herbert Addison, Assoc. M. Inst. C.E.; No. VI., "The Discharging Capacity of Side Weirs," by Dr. George Stephen Coleman, Assoc. M. Inst. C.E., and Dempster Smith; No. VII., "Evaporation by the Vapour-compression Method," by Thomas Evans Houghton, Assoc. M. Inst. C.E.; No. VIII., "Inchinnan Opening Bridge," by Dr. William Bertram Hall, Assoc. M. Inst. C.E.; and No. IX., "Catenary Measurements," by Rollo Appleyard, M. Inst. C.E. Edited by Dr. H. H. Jeffcott, Assoc. M. Inst. C.E., secretary of the Institution. London: The Institution of Civil Engineers, Great George-street, Westminster, S.W. 1. 1923.

Practical Hydraulic Engineering Problems.

MR. O. C. A. VAN LIDTH DE JEUDE (formerly Civil Engineer to the Netherlands Government Public Works Department, and now technical managing director to the Netherlands Harbour Works Company), delivered the second and third of his course of six advanced lectures in engineering in the University of London at the Institution of Civil Engineers on Wednesday, February 27th, and Friday, February 29th.

LECTURE II.—BRUSHWOOD CONSTRUCTIONS.

The second lecture, on February 27th, at which Dr. Worthington, Past-president of the Institution of Civil Engineers, presided, dealt with brushwood constructions for protecting foreshores, banks of canals, rivers, &c. The lecturer pointed out that the use of brushwood is one of the oldest methods for the purpose of preserving the banks of rivers and dykes, especially in the Netherlands, where the willows mainly used for it are extensively cultivated. Very little theory, he said, can be applied to this form of work, and its success depends mainly upon practical experience. After giving a brief account of the methods by which the willow and other forms of growth are cultivated for the purpose, it was pointed out that in 1915 about 250,000 acres, or 38 per cent. of the total Woodlands in Holland, were covered by willow and other growths used for brushwood, the willow tree being ready for cutting after three to four years, other kinds of wood taking a longer period. A model was shown of the most usual type of brushwood construction used for the preservation of banks and foreshores. It was in the form of a mattress of brushwood woven together in a particular manner. There are usually two bottom layers, the sides of which are surrounded with a kind of fencing, the whole of the upper surface being divided into sections for the purpose of carrying the ballast for sinking, where necessary, and also for taking a top layer of sand which is often interposed between successive mattresses. Special stress was laid by the lecturer upon the attempts which had been made from time to time to use reinforced concrete instead of brushwood, but the latter, especially with the conditions in Holland, has proved to be by far the best form of construction, particularly under water. In this connection he mentioned the Commission which was appointed some years ago to consider the application of a reinforced concrete system of protection for the Zuider Zee, and the preference expressed for brushwood construction. The work was not immediately proceeded with at that time, and owing to the magnitude of it fears were expressed that there would be a shortage of brushwood, with a consequent increase in the price. When the scheme was taken in hand, subsequently, it was decided that a considerable saving in the quantity of brushwood required could be secured by placing layers of sand, &c., between the various mattresses, so that the fears as to a possible shortage and high price of brushwood did not materialise. (The scheme for the Zuider Zee will be described in detail in the final lecture.)

Where it is necessary to use brushwood mattresses under water to protect the bottom, the sinking of them is effected by loading them with stone from lighters to the extent of 400 lb. per square foot. The lecturer sketched various modifications of the mattress form of brushwood construction for use on sliding foreshores, for groynes, jetties, &c., and indicated how that form of construction is built up *in situ*, and how economy in brushwood construction, with additional strength, is obtained by interposing layers of sand and seaweed. He emphasised the point that whereas sand and seaweed alone are absolutely useless against the effect of water, when combined with brushwood they form an admirable and cheap method of protection. Brushwood mattresses for sinking to the bottom are made on shore and towed to where they are wanted.

Reference was made to disasters which have overtaken the dyke system in Holland on one or two occasions, and some account was given of the method of repairing the breaks in the dykes by means of brushwood constructions of the kind previously referred to. Indeed, brushwood for this purpose has been found to be the only effective method of keeping back the water from inundating the low-lying lands of Holland permanently. As an example of how the work is done, the lecturer showed a section of a coast line with two or three projecting points, behind which was a dyke to protect the low-lying lands which otherwise would be inundated from the foreshore. By building out brushwood constructions into the sea from the projecting points, the natural line of the current was correspondingly pushed out from the foreshore, and so the scouring action of the water was more or less arrested. Experience had shown it wise to leave a distance of about 100 yards from the foundations of the dyke to the theoretical line of the current. This experience has special reference to the coast of Holland and to the Zuider Zee, which is practically an inland sea, where the foreshore has a top layer of clay with a very fine sand underlying. If, as sometimes happens, the top layer of clay is broken down, the sand flows out horizontally like water, letting down the foreshore, and it has been found that by allowing this distance of 100 yards between the dyke and the theoretical line of the current, the dyke is sufficiently protected against a break or slide in the foreshore. No steps are taken when such slides or breaks in the foreshore take place on these particular coasts, for the reason that the damage is repaired by nature so permanently in the course of time that a break has never been known to occur twice in the same place.

Special reference was made to the serious catastrophy in 1916 in the Province of North Holland, which is protected by dykes against the Zuider Zee on the east side, and against the North Sea on the west side, and the many discussions which took place as to the best methods of closing the breaches. It was proved abundantly, he said, that brushwood construction was most effective, although, again, some sort of competition was put up by reinforced concrete. The openings caused by the accident ranged from 100 to 300 yards long, and temporary barriers had to be put up before the water could be pumped out and permanent repair work executed. An important example of the use of brushwood on a waterway was the work carried out in the Hook of Holland to improve the entrance to Rotterdam 10 miles down from the North Sea. Two jetties were first built out into the waterway at a distance of about 1000 yards to the level of high water, but it was found that they did not secure sufficient scouring effect during the ebb and flood tides to maintain the required depth of waterway, and so a short jetty was built in between them to the level of low water with the object of increasing the speed of flow and, consequently, the scouring effect on the ebb tide, without interfering with the flow of the water on the flood tide.

A casual reference was made to the fact that brushwood has been used with success in China, and that although expert knowledge is required in the manufacture of the mattresses and other constructions, it has been found possible to train Chinese labour for the purpose.

As on the previous occasion, the lecturer concluded by showing a number of lantern slides illustrating the various types of work which he had described.

LECTURE III.—RIVER IMPROVEMENTS IN THE NETHERLANDS.

Sir John Dewrance, Past-president of the Institution of Mechanical Engineers, presided at the lecture on February 29th, when the subject of river improvements in the Netherlands was dealt with.

The lecturer first explained the main river system of Holland. From the point where the Rhine enters Holland from Germany at Pannerden, there is a northern arm known as the river Lek, which flows to Rotterdam and links up there with the new waterway to the Hook of Holland; and a southern arm, known as the river Waal, which also runs into the estuary south of Rotterdam and also links up with that town. Running north from the Lek, near Pannerden, is the river Yessel, which terminates in the Zuider Zee, whilst coming up from the south, from Belgium, there is the river Maas, which travels north and then turns westward to the estuary, south of Rotterdam. The most important of these rivers are those which flow from the Rhine and take the shipping, which has been such an important feature of the development of the port of Rotterdam. For centuries efforts have been made to maintain a suitable fairway, the importance of which was emphasised by the figures given showing the enormous increase in the amount of water-borne traffic. Since the war, however, said the lecturer, the Rhine navigation has seriously declined to the great disadvantage of Rotterdam, and the opinion was expressed that it will take several years before Rotterdam develops to its normal condition again.

Coming to the main subject, namely, the river improvements in the Netherlands, the lecture was divided into the following three sections:—(1) The separation of the rivers Waal and Maas; (2) the improvement of the Waal to give a fairway of 10ft.; and (3) canalisation of the Upper Maas. Incidentally, reference was made to the fact that forty years ago the British Royal Commission on Canals and Waterways, presided over by Lord Shuttleworth, paid a visit to Holland and inspected the system of canals there, the idea at the time being to improve the British canal system. Presumably, however, said the lecturer, the scheme fell through on account of the keen competition of the railways in England. Before the war, in Holland, however, the cost of transportation on the canals was about one-quarter that of railway transport.

Dealing with the improvement of the Waal—the main river for the Rhine navigation, to Rotterdam—comment was made upon the fact that the natural course of the river was very bad from the theoretical hydraulic point of view, and works have been carried out to give a lower channel in the river with sufficient capacity for the discharge of the summer water and a higher channel to deal with the winter water. The first efforts on the Waal were made as far back as 1815, when the navigation demands were very moderate; but as time went on it was found that large quantities of sand were shifting down the river and forming shoals which, naturally, offered serious impediments to navigation. From 1890 to 1910, further work took place with the object of securing a fairway, and it was found advisable to reduce the width of the lower channel and to widen the upper portion of the banks of the stream, especially on curves. This work has been effective in securing a greater scouring effect, and so maintaining the lower channel free. Moreover, it has been found that the rearrangement of the course of the stream in order to get longer curves also aids in preventing silting up. In this way, whilst the width of the lower channel was gradually reduced, the width of the river at the surface was increased, and very satisfactory results have been achieved in this way. In order to prevent silting up, protective works using the brushwood construction referred to in the previous lecture, were installed at different points, at an angle, so that any shifting sand was caught at the point of junction between the brushwood construction and the bank, and held there more or less permanently, leaving the lower channel free. Thus, it has been possible materially to improve the fairway of the river without any dredging operations.

Dealing with the works involved in the separation of the rivers Maas and Waal, it was pointed out that in 1893 these rivers met at a place called Loevenstein, but difficulties arose because, whereas the Waal was what is known as an ice river, having to deal with ice water from melting snows lower down, the Maas is a rain river. Thus, whilst the Waal had heavy floods in the winter time only, the water level in the Maas was irregular and high water might be expected at any time of the year. Consequently, works were taken in hand with the object of separating the two rivers, and the Maas was carried along separately to the estuary at the Hook of Holland. This work involved the construction of certain canals, dykes, &c., in order to prevent any of the Waal water going into the Maas, as before. The new branch of river thus made had a length of about 20 miles, and took something like twenty years to construct, the opportunity being taken to improve the Waal also. The great length of time the work took to complete was due to difficulties encountered with peasant landowners, who, said the lecturer, always regard engineers as born enemies who wish to take away their revenues and spoil their property. Whilst the work of constructing the new channel took twenty to twenty-five years, the actual closing of the old junction between the Waal and the Maas was accomplished in three months. Incidentally, the lecturer commented upon the joy to an engineer, as in this case, at being able to deal with a problem anew instead of having to encounter the difficulties usually met with in the reconstruction and improvement of existing rivers.

Commenting on the new waterway from Rotterdam to the Hook of Holland, mention was made of the fact that it was originally anticipated that a depth of 6½ m. would be sufficient, but eventually a depth of 10 m. was obtained. Since then, however, the increasing size of vessels had demanded a greater depth than 10 m., and at Amsterdam a new lock is under construction with a view to giving a depth of 12½ m. For the moment, therefore, said the lecturer, Amsterdam is on top, since it is impossible to get a depth of more than 10 m. from Rotterdam to the sea.

Coming to the improvement of the upper Maas, reference was made to the fact that a Commission was appointed in 1906, consisting of half Belgians and half Dutch representatives, and a scheme was drawn up. Owing to the war, however, this work has not been begun in its entirety. The works on the part of the river in Dutch territory are now in hand, and negotiations are in progress with the Belgian Government, which, it is hoped, will lead to operations being carried out on the lower part of the river. The works now being carried out on the Dutch Maas consist of the construction of a series of locks of the long and narrow type now being commonly adopted and known as the tow-type, the object being to allow tugs to enter the locks with two lighters without, as in the case of shorter locks the necessity of disconnecting the tugs from the lighters and sending the lighters in one at a time. Another feature of these long and narrow locks is, that in some cases they are divided in half by a second series of gates, so that where only one lighter wishes to pass through, only half the lock is employed and, consequently, there is a great saving in water. Many of the vessels using the river have a length of 230ft., a width of 40ft., and a draught of 10ft., and are of 2000 tons capacity. Weirs are also being constructed to keep up the level of the water at four or five places. A series of lantern slides was again shown to illustrate the type of work being carried out.

The next lecture, on March 17th, will deal with "Harbour Engineering Abroad."

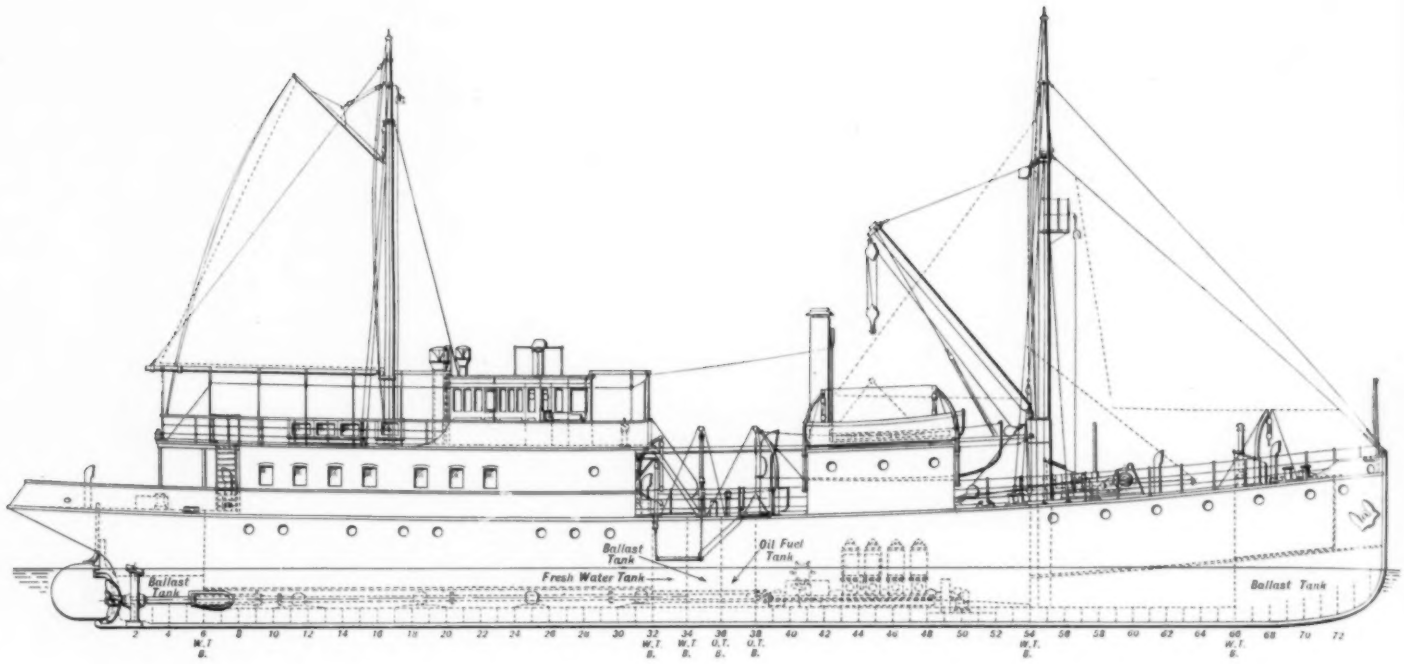
SIXTY YEARS AGO.

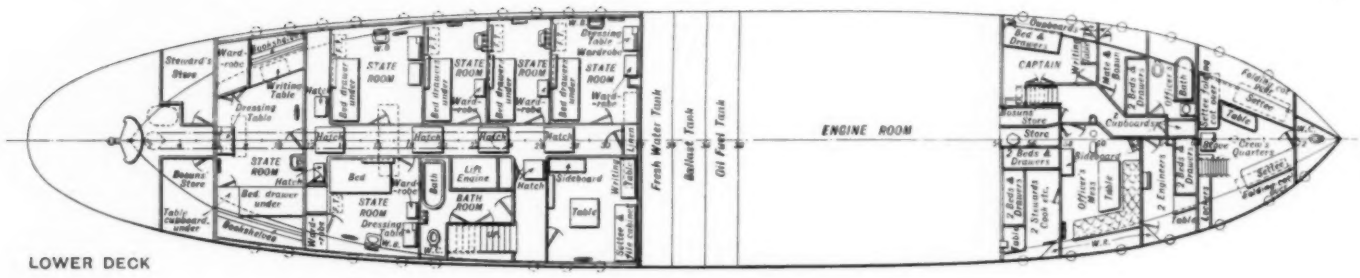
IN our issue of March 4th, 1864, we recorded the successful trials of the twin-screw steamship Edith, built and engined by Messrs. Dudgeon, of Millwall. This vessel had a length of 173ft., and a tonnage of 550 tons, and was fitted with simple four-cylinder engines which indicated 894 horse-power at 100 revolutions per minute. Her two three-bladed propellers had a diameter of 8ft. 6in. and a pitch of 16ft. On trial she developed a speed of 13¼ knots, and demonstrated by "manœuvring about in all possible ways . . . the great advantages attained by the double screw and the ease in handling." She was the twelfth twin-screw vessel built by Messrs. Dudgeon. "The twin-screw principle," we find it recorded, "is evidently fast coming into favour now that its benefits have been so satisfactorily tested." . . . At the present moment interest is being manifested in the revival of the proposal to provide cross-river communication at the mouth of the Thames by means of a tunnel starting from Gravesend. It is, therefore, interesting to discover that the object was also a matter of debate sixty years ago. In our issue of the date quoted above, we find a letter addressed to the Editor in which the writer outlined a scheme for an underwater railway which would permit cross-river traffic without interfering with navigation. He proposed that, the bed of the river being previously dredged, a line of rails should be laid down on it from shore to shore, and that on these rails an iron staging, having its top above high-water level, should run. The staging was to be provided with rails to receive a train and was to be propelled by an engine, the cylinders and cranks of which were to be housed in water-tight compartments. . . . In a brief paragraph we expressed our regret at learning that Mr. Richard Roberts, then nearly seventy-five years of age, was very ill and unlikely to recover. In view of his many invaluable inventions, such as the planing machine, the self-acting mule, the slotting machine, the gear cutting engine, and the system of fixed templates and standard gauges, a movement had for long been agitated to present him with a suitable and substantial testimonial. We hoped that this testimonial would not come too late. It did, for Roberts died a week later without receiving the much-needed benefit of the considerable sum which had been subscribed with the object of relieving the straitened circumstances of his later years. . . . Commenting upon a recent case involving the assessment of professional fees, we discussed in a leading article the status of engineers in this country and abroad.

WE learn from the *Electrical Review* that La Société Française des Electriciens, in conjunction with the Syndicat des Producteurs et Distributeurs d'Energie Electrique, is organising a series of tests of apparatus and methods for reducing current losses in transformer pillars when out of operation. The object in view is particularly that of distributing systems in rural areas where transformer pillars are used in a somewhat irregular manner which entails considerable losses. The organisers hope that as a result of the trials it will be possible to install in such pillars apparatus which will automatically put the transformers in and out of circuit in accordance with the varying demand for electricity, or some arrangement which will reduce the existing losses. Manufacturers of apparatus designed for this purpose are invited to take part in the trials, which are to be held in July next. Entries must be sent to La Société Française des Electriciens, 14, Rue de Staël, Paris—from which further particulars can be obtained—before April 15th next.

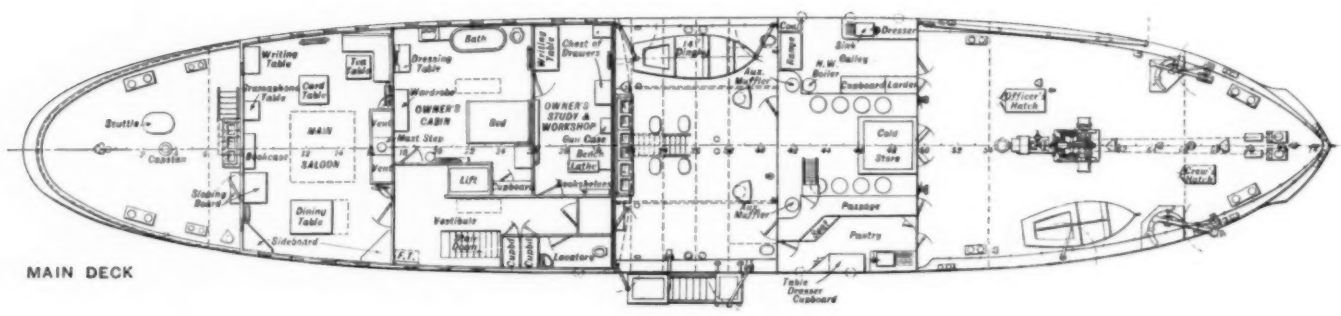
THE TWIN-SCREW MOTOR

THE NOVA SCOTIA STEEL AND COAL COMPANY.

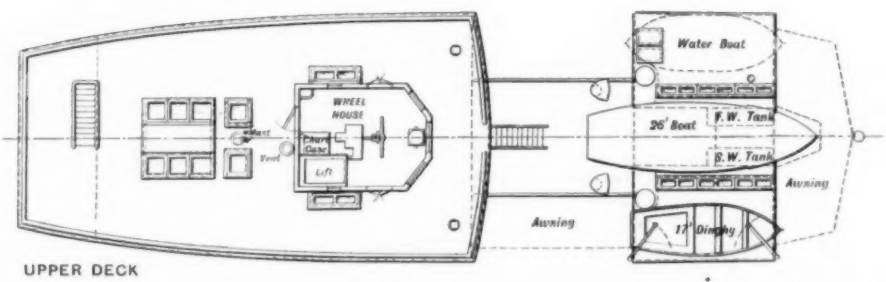




LOWER DECK

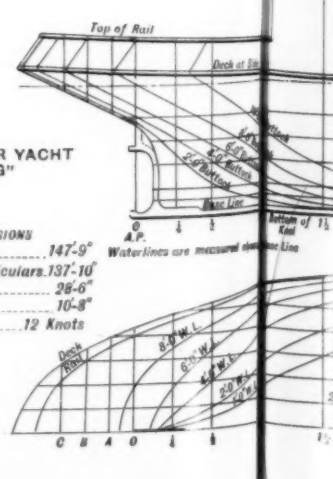


MAIN DECK



UPPER DECK

LINES OF MOTOR YACHT "SEA KING"



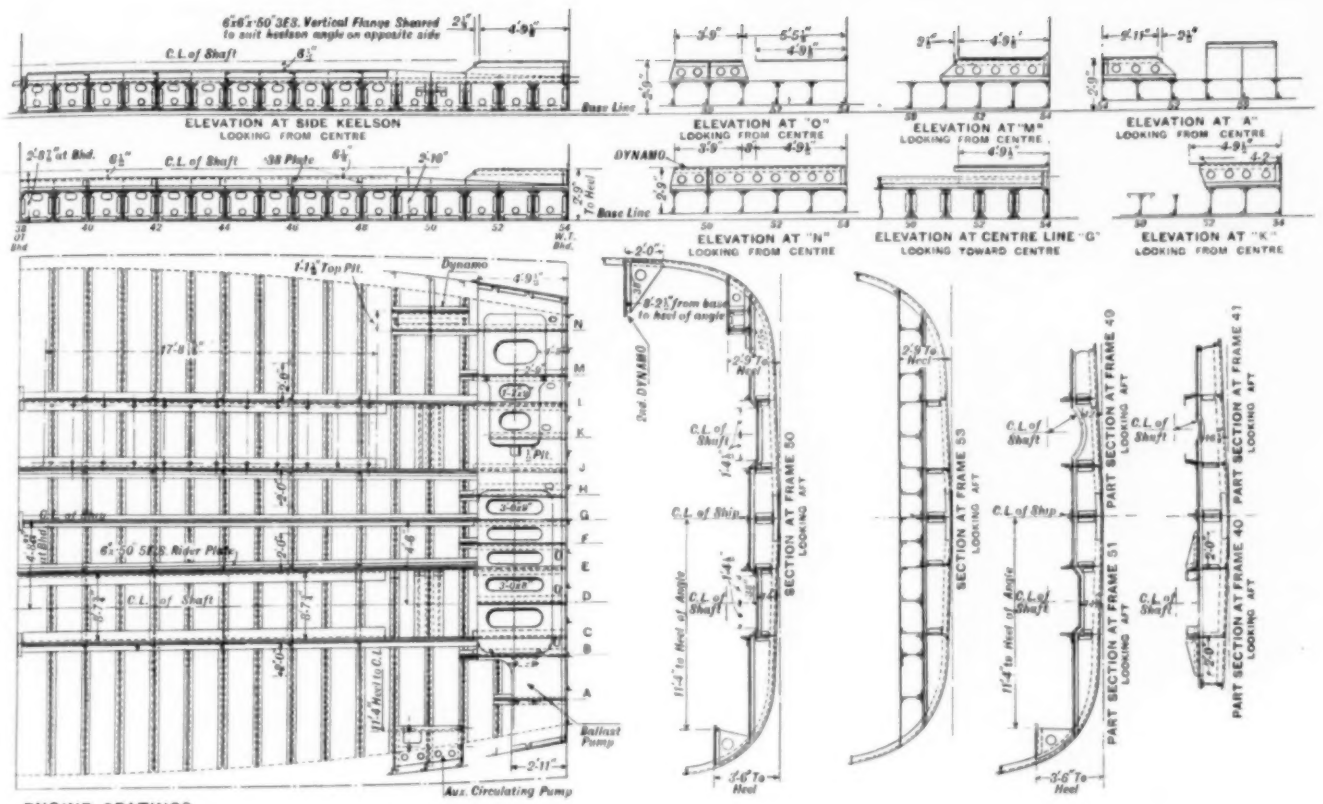
PRINCIPAL DIMENSIONS

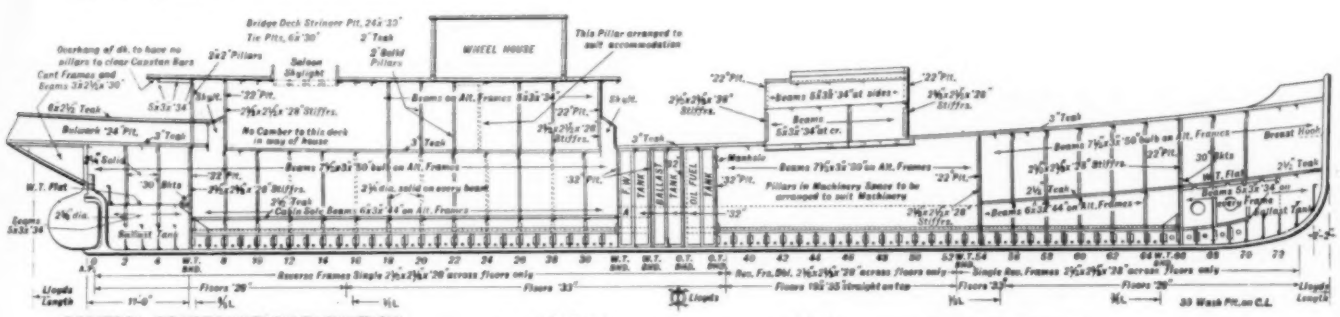
Length Overall	147'-9"
Length Between Perpendiculars	137'-10"
Breadth Moulded	26-6"
Depth Moulded	10'-8"
Speed	12 Knots

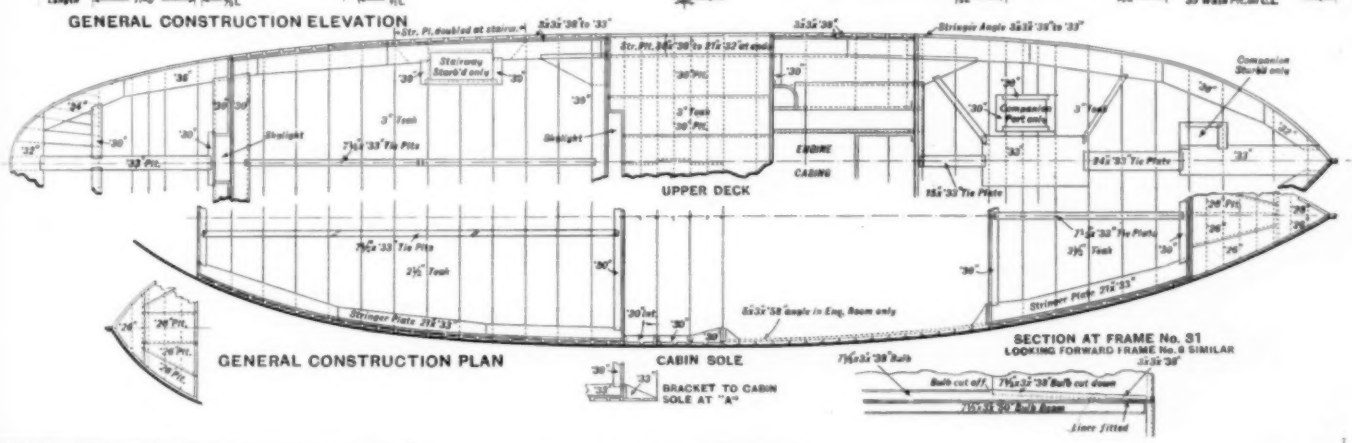
Waterlines are measured

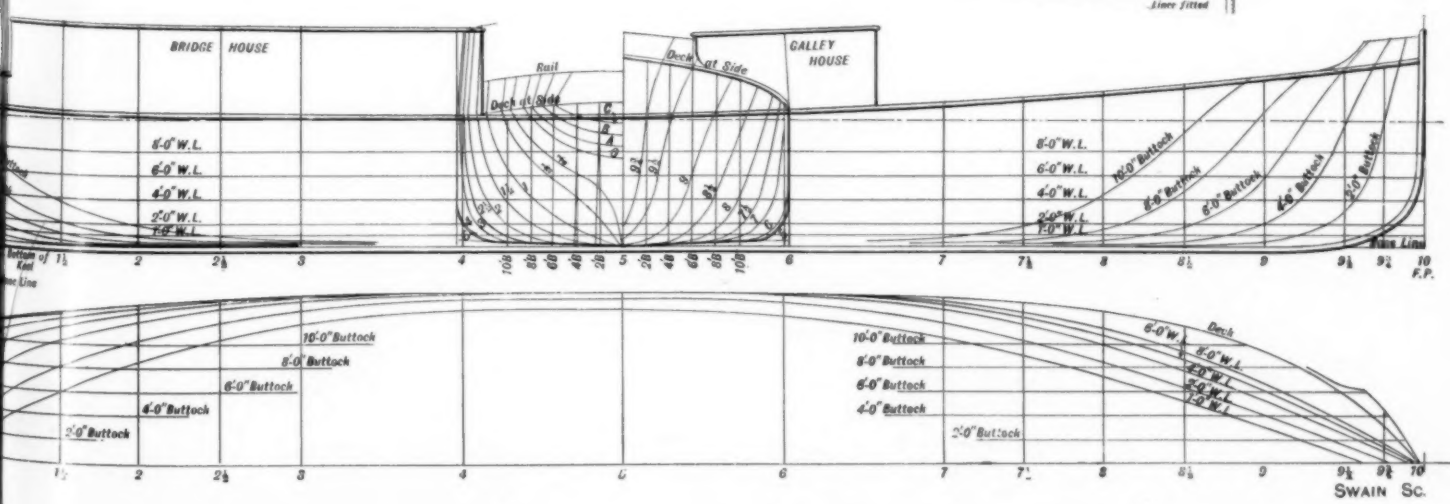
OTOR YACHT "SEA KING"

L COMPANY, LIMITED, NEW GLASGOW, BUILDERS






UPPER DECK
GENERAL CONSTRUCTION PLAN
CABIN SOLE
BRACKET TO CABIN SOLE AT "A"
SECTION AT FRAME No. 31
LOOKING FORWARD FRAME No. 6 SIMILAR

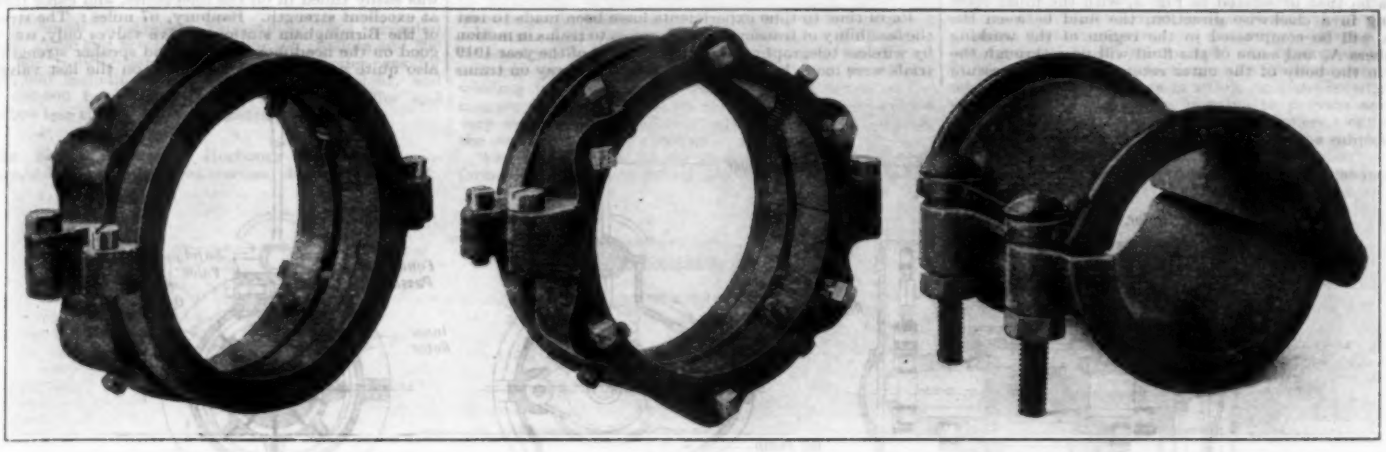


Emergency Pipe Clamps.

THE two devices shown in the engravings below have just been introduced into this country by W. H. Willcox and Co., Limited, of 38, Southwark-street, London, S.E. 1, with the idea of providing means for rapidly and effectively stopping leaky steam or water pipes. The arrangement shown in the two views on the left is for stopping leaks where the pipe is screwed into a fitting, such as a sleeve or elbow, while that on the right is used in closing a split or punctured pipe.

The pipe joint clamp takes the form of a substantial ring split across the diameter and bolted together. This ring is slipped on to the pipe and fixed securely by four radial set screws. There is another split ring, which is arranged close up to the fitting and inside the clamp. This ring is recessed to accommodate a circular piece of packing, and behind the packing there is another light ring. Six set screws, pointing more or less axially through the clamp, bear against the last mentioned ring, and are used to force the packing up against the joint. The recess for the packing is so formed that the material is guided into the screwed joint, instead of being squeezed out round the edges, and the makers say that a leaky joint can be effectively staunched even when under full pressure. The principal parts are malleable cast iron, and the whole device appears to be well made. The only objection we can see to its use is the extra stress it must set up, tending to pull the pipe out of its fitting, but unless the screw is very badly cut, or corroded, this extra stress should not be a serious objection.

The construction of the second type of clamp is so obvious from the engraving that it hardly needs any description. It is formed as two malleable castings, connected together on one side by a long hinged joint, and on the other by two or more bolts. The bosses for the bolts are cast fairly deep, so that the nuts can be reached conveniently with a spanner. The clamp is simply slipped over the pipe and tightened up over a leak with a piece of jointing material to make it tight. These sleeve joints are made in eighteen sizes for pipes from ¼in. up to 12in., while the joint clamp is made for pipes of from 1in. to up 18in. bore.



EMERGENCY PIPE CLAMPS

INSTITUTION OF ELECTRICAL ENGINEERS.

THE annual dinner of the North-Western Centre of the Institution of Electrical Engineers was held at the Midland Hotel, Manchester, on Friday, 29th ult. The chairman of the Centre, Mr. G. A. Juhlin, presided, and there was a very large attendance of members and guests, including Mr. E. D. Simon, Mr. R. Noton Barclay, Sir Harry Haward, Vice-chairman of the Electricity Commission, Sir Holberry Mensforth, Sir Philip Nash, Dr. A. Russell, F.R.S., President of the Institution, Mr. S. L. Pearce, M. Inst. C.E., Alderman Walker and Mr. A. B. Mallinson (hon. secretary). Sir Philip Nash, in proposing the toast of "The City and Trade of Manchester," said said the wisdom of the unification of power supply could not be disputed. With regard to the Manchester suburban traffic problem, he remarked that it would be best solved by the electrification of the railways. He prophesied an immense future for electricity in connection with social and domestic supply purposes, and mentioned that the Manchester Corporation was about to build fifty all-electric houses. Dr. A. Ree, President of the Manchester Chamber of Commerce, responded. The toast of "The Institution of Electrical Engineers" was proposed by Mr. E. D. Simon, who referred to the immense growth of the Institution, the membership of which had increased from 110 fifty years ago to 11,500 at present. Those figures, he said, were typical of the rate of growth of the electrical industry. During the last year, he added, the Manchester Corporation sold 20 per cent. more current than in the previous year. In his reply to the toast, Dr. Russell said that the Institution was very prosperous, and was the largest of all the engineering societies. The North-Western Centre was the strongest, embracing, as it did, over 1000 members. Dr. Russell spoke in high praise of the professional staff of the College of Technology. He reminded those present that the centenary of Kelvin would be celebrated this year. Kelvin was born on June 26th, and it had been decided to have a public celebration of the centenary on July 10th. "Our Guests" was proposed by the chairman, Mr. G. A. Juhlin, and responded to by Sir H. Haward, who referred to the considerable part which Lancashire played in the electrical affairs of the country. It was, he said, remarkable that in spite of the general trade depression there was an enormous advance in the development of the use of electricity, and he foretold even a greater advance in the immediate future.

THE SOUTH AFRICAN DIAMOND FIELDS.

WITH a declaration of over 10,000 carats in each of the last two months of 1923, the gross output of diamonds for the alluvial fields of the Transvaal Province of the Union of South Africa, has touched high-water mark of annual production. The output for the whole year has been declared at 123,214 carats of a declared value of £845,325, an average of 137/3 per carat. The best previous year, on the basis of carats found, was in 1920, when 94,606 carats were registered, of a gross value of £1,099,746, the average price per carat being 232/6.

So far from there being any signs of the alluvial deposits being exhausted, future prospects are apparently better than ever. During last year a number of new areas of very considerable extent and richness were proclaimed. Almost as many more are already known to exist and will be proclaimed this year; in fact, 1924 may very well put up another record. Whether the Government's action, in throwing open so many alluvial diamond areas is in the interest of the industry as a whole may, however, well be doubted.

There have been some big finds quite recently in the alluvial diggings. A poor digger at Bynestpoort, near Kamelfontein, in the Pretoria district of the Transvaal, found last month a stone of solid block shape, looking as if it had been broken off a still larger one. It is of brown colour and weighs 416¼ carats.

Consultation with friends left little doubt that it was a diamond, and he eventually disposed of it in Kimberley for about £3000. Since then the stone has been purchased by an American buyer, also of Kimberley, at a price considerably above what it first realised. Before the re-sale, however, it had been subjected to a chemical process which has improved it considerably in colour.

Another lucky digger at Niekerks Rush, on the Vaal River Estate, near Kimberley, recently found a beautiful blue-white diamond valued at £1000. The largest diamond found for a considerable time in the Cape Province was picked up on the "Amontia" farm at the end of January. It weighed 264 carats and was sold for £5000. Next to it comes a Cape Yellow, said to be "as large as a pigeon's egg," which was picked up on a farm near Prieska just before the New Year. It weighs fully 100 carats. As the owner of the farm had no prospecting licence and his title contains no rights to diamond and precious stones, the stone belongs to the Government, the finder getting 10 per cent. of its value.

The question is beginning to arise, but is not yet fully realised, if the alluvial diamond areas continue to increase their output largely, how long will De Beers and the other controlling interests be able to exercise a real control and so maintain the price of the stones? For it is not alone in the Transvaal and Cape that alluvial diamond mining is increasing. The South-West Protectorate is a big factor, and one could enumerate at least half a score of other places which are going to be almost as formidable.

BRITISH ARCHITECTS' CONFERENCE.—The annual Conference of the Royal Institute of British Architects and its allied societies in the United Kingdom and the Overseas Dominions will take place at Oxford from July 9th to 12th, 1924.

NEW REGULATIONS AS TO SHIPS' NAVIGATION LIGHTS.—The Board of Trade has issued new regulations regarding navigation lights on British ships. These regulations, which are based on the recommendations of the Departmental Committee on Ships' Lights, will apply to all new lights supplied to ships on and after September 1st, 1924, and to all ships' lights on and after September 1st, 1927. New standards are laid down with the object of securing that the requirements of the International Collision Regulations are fully complied with, and, after the dates mentioned, navigation lanterns will be passed only if they are of a type which has been approved by the Board of Trade as complying with the new standards, or if it is clearly demonstrated that they fulfil the requirements of the Collision Regulations in all respects. Copies of the "Instructions as to the Survey of Lights and Sound Signals, 1924," may be purchased—price 1s. net—through any bookseller or direct from His Majesty's Stationery Office at any of the following addresses:—Imperial House, Kingsway, London, W.C. 2; 28, Abingdon-street, London, S.W. 1; York-street, Manchester; 1, St. Andrew's-crescent, Cardiff; or 120, George-street, Edinburgh.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

POWDERED FUEL.

SIR,—Would it not be better to admit at once that the Lakeside figures as given by Mr. Brownlie are wrong, than to try to justify them at all costs, as some of your correspondents seem to be desirous of doing. Mr. Leach, in your issue of last Friday, adopts the *tu quoque* method of argument, and gives a diagram purporting to show that the Parsons evaporation line for Dalmarnock also cuts the base of the diagram. In view of the fact that the Dalmarnock engineers have repeatedly shown that it does *not* do so, Mr. Leach's contention is somewhat bold, to say the least of it. In his recently published book on "Power Station Efficiency Control," Mr. John Bruce gives, on page 225, the Dalmarnock diagram, and shows that the equation to the line is C = 5000 + 0.15 W. As it was Mr. Bruce who introduced the system at Dalmarnock, I think his statement as to the position of the line on that station may be taken to settle the question.

Further to support his case, Mr. Leach states that the Lakeside results refer to full-load tests. This again is inaccurate, as anyone referring to Mr. Brownlie's paper can see for himself. The tests plotted by Mr. Napier range from 47,840 lb. of coal burnt per shift to 90,800 lb. per shift, so that it is absurd to pretend that the boiler was at full load all the time. The ratio is nearly two to one, and the range is ample to establish the slope of the Parsons line, particularly in view of the phenomenal accuracy claimed for the tests by Mr. Brownlie. Furthermore, if it is said that there are not sufficient tests to establish the line, the obvious answer is that there are also not sufficient tests to establish the efficiency of Lakeside.

In your issue of February 22nd, Mr. Leonard Harvey raises the question as to whether the Parsons line would "work" in the case of an oil-fired station, or a pulverised coal station, in which boilers are not kept with banked fires. It certainly works for an oil-fired station, for some time ago I saw some diagrams of an oil-fired station in America, and as it was a standby to a hydro-electric plant, the conditions were excellent for elucidating the point raised by Mr. Harvey. In this station the equation to the Parsons evaporation line was C = 2629 + 0.0773 W, in which C represents the pounds of fuel oil burnt per shift and W is the corresponding weight of water evaporated. It will therefore be seen that in this station 2629 lb. of oil were burnt per shift to make up the radiation and other constant losses in the boiler-room. The idea that there are no no-load losses in a boiler-room fired with oil or pulverised coal is quite erroneous, as will be evident on a moment's reflection. Whether the boilers are producing steam or not, if pressure has to be kept up they must be kept hot, and they will be radiating just as freely as when working. Heat therefore has to be supplied sooner or later to make good the radiation losses. In the case of coal-fired boilers this heat is provided by the banked fires, whereas in oil or dust-fired boilers, if the burners are shut down, they have to be re-started all the sooner. A boiler cannot be stopped from radiating heat by shutting off its fuel supply.

Another question that has been raised in this correspondence is whether the Parsons lines are straight or whether they bend at low loads in the manner required to make the Lakeside test figures possible. I do not think anyone who has had any practical experience of the method, will have any doubt that they are straight within the limits of possible measurement.

The Blackburn diagrams, published in *Engineering* of October 26th last year, are pretty conclusive, but I once knew of a case which I think definitely settled the point. The station in question was quite a large one, working in parallel with another, and, owing to peculiar circumstances, it was operated for several shifts at the smallest load that could be carried. The range of load during the month was therefore very great indeed, and when the results were plotted down, the light load shifts came practically on the vertical ordinate of the diagram. The nature of the Parsons line in the neighbourhood of zero load could thus be determined with great certainty, and there was no possible question about its straightness.

I note that Mr. Brownlie has not replied to Mr. Napier's repeated challenge, either to withdraw the emphatic statement in his book that boilers cannot possibly be operated with a flue gas temperature below 212 deg. Fah., or to withdraw four of the tests upon which his argument as to the efficiency of the Lakeside station is founded. The flue temperatures of the four tests in question are 168 deg., 196 deg., 205 deg. and 204 deg. Fah. respectively. I wish he would tell us what he would like us to believe in this matter.

C. SAXTON.

London, W.C. 2, March 3rd.

A New Variable Speed Gear.

A new form of speed change gear embodying interesting constructive features, and designed for quick reversal with an infinite range of speed gradation from rest up to full speed in either direction, forms the subject of a recent article by Oscar Keller in our Swiss contemporary, the *Schweizerische Bauzeitung*. The apparatus is of the fluid transmission type, and was invented by Heinrich Schneider, of Winterthur. The gear is protected by patents, and takes its name after its inventor. The first Schneider gear to be constructed was built at the Swiss Locomotive Factory, Winterthur, and after severe tests, it was applied to a large vertical boiler-plate bending machine with, we learn, very satisfactory results. The principle on which the gear works is illustrated diagrammatically by the drawings we reproduce in Figs. 5 and 6. It will be seen that the principal parts of the apparatus comprise two rotors placed one within the other, and each furnished with sliding vanes. The vanes of the outer rotor are in contact with an external housing fixed excentrically with regard to the rotor, while the internal rotor is so suspended that its excentricity with regard to the outer rotor may be varied between the two extreme positions—shown in Figs. 5 and 6 respectively. Assuming the relative position of the two rotors be that illustrated in Fig. 5, with the inner rotor turning in a clockwise direction, the fluid between the vanes will be compressed in the region of the working chambers A, and some of the fluid will pass through the slots in the body of the outer rotor and set up pressure in the working chambers B. At the same time suction will take place in the region of the working chambers C, and fluid will be drawn through the slots in the body of the outer rotor setting up negative pressure in the region of the working chambers D. With these pressure conditions obtaining, the outer rotor moves in a clockwise direction or the same direction as that in which the inner rotor is turned. If now the internal rotor be moved up till it is concentric with the outer rotor there will be equal pressure on all the chambers and no fluid will pass from one rotor to the other, hence there will be no movement of the outer rotor relative to the inner. Again, if the internal rotor be now raised still further till it occupies the position shown in Fig. 6, a reversal of pressure conditions takes place, the chambers corresponding to D becoming a region of positive pressure in the outer rotor, and the chambers B a region of negative pressure. The fluid will now circulate the opposite way, the outer rotor moving in a counter clockwise direction, with the inner rotor turning clockwise as before. It will thus be seen that by altering the relative position of the rotors complete reversal and infinite gradation of speed from rest to full load is obtained in either direction. In Figs. 1 and 2 we show vertical and horizontal sections of the gear as actually constructed, while Figs. 3 and 4 indicate by means of cross-sections the relation of the rotors and the cast iron housing containing them and forming a base for the gear. We need hardly refer to the principle of the sliding vanes, since similar vanes have been in use for some years on compressor work with considerable success. The new feature would seem to be the combination of the two rotors and the means of altering their relative position one to the other, and of permitting a flow of fluid through the rotors and round equalising passages in the casing so as to form a closed circuit.

The motion is transmitted from the driving shaft to the inner rotor, and from the outer rotor to the driven shaft by means of cut gears, and roller-type bearings are used throughout. Speed regulation is controlled by means of an operating lever pinned to a lay shaft having excentric ends, to which the inner rotor housings are attached by means of suspension links. The operating lever moves over a sector showing the speed range in either direction. Fig. 4 serves to indicate the arrangement of equalising passages and the safety valve. The gear-driven oil pump—shown in Fig. 1—draws its supply from the gear casing and delivers oil under pressure through a channel in the lower part of the gear, which terminates in a passage closed by a double-seated valve. The function of this valve is automatically to make the connection between the oil delivery passage and that side of the gear which at the moment happens to be the suction side. Among the advantages claimed for the gear we have described are its small and compact size, simplicity and noiseless working. It requires little attention, and would seem to fulfil all the requirements of a speed change gear for machine tools or lifting appliances. No particulars are given as to the efficiency of the gear or the ranges of speed for which such gears may be designed, but we understand that it may be built in the smallest sizes and for any desired range of speed reduction.

Wireless Telegraphy on Trains.

From time to time experiments have been made to test the feasibility of transmitting telegrams to trains in motion by wireless telegraphy. At the latter end of the year 1919 trials were made by the Great Western Railway on trains running between Paddington and Fishguard and Paddington and Bristol. An aerial fixed on top of the coach was used, and signals were picked up with varying success. The recent trials on this company's system between Paddington and Birmingham showed a distinct improvement in reception, especially as an inside aerial was employed. An eight-wheeled brake van lighted by gas was used. On the journey to London the van was placed next to the engine, and on the journey to Birmingham at the rear of the train. The aerial was of the twin T type, with an approximate length of 50ft., and roughly 1ft. below the roof and 6ft. above the floor. An earth connection was made through the handle of the hand brake or, alternatively, through the vacuum brake pipe.

The receiver was designed by Mr. C. H. Gardner, and constructed at the works of the Midland Radio-telephone Manufacturers, Limited, Brettell-lane, Stourbridge. Two stages of high-frequency were used, by means of two tuned anode circuits, with reaction feed back on to the plate circuit of No. 1 valve.

The following is a log of the journey :—The train left Paddington at 4.10 p.m., and with five valves in use the transmission from the London broadcasting station was received on the loud speaker with considerable strength. On leaving the covered-in station, the strength at once rose about 15 per cent. Greenford, 7 miles from London : No appreciable loss in strength. Loud speaker still loud, in spite of considerable noise caused by travelling in empty brake van. Northolt, 10 miles : By this time the train was running into more open country. It was also climbing steadily. The transmission from the London station was stronger here than in any other part of the journey. It was noticeable that there was a slight fading of strength in passing through the larger stations, even if they were not covered in. Gerrards Cross, 17 miles, 4.36 : Still working the loud speaker with five valves, and it was still audible above the noise of the train, which was considerable, owing to the increase of speed and the emptiness of the brake van. The train noises appeared to be increased by about 400 per cent., and the strength of the loud speaker was therefore much greater than a considerably raised human voice. Beaconsfield, 4.40 : On switching on the sixth valve at this point, the loud speaker strength became almost unbearable, and conversation by shouting was almost impossible. High Wycombe, 26 miles : A slight dropping in strength was noticeable at this point. In passing through a tunnel in this district the signals were entirely cut out, but owing to the speed of the train the gap was short. When passing under bridges, a fading was noticeable, but it was insufficient to interfere with the reception. In deep cuttings this was also noticeable, but in cuttings which did not rise appreciably above the aerial, the fading was almost non-existent. Passing through marshy and wet district also seemed to cause a slight loss of strength. About 3 miles from Bicester quite a drop in signal strength was noticed, but no reason was apparent from looking at the surrounding country from the train. The strength was never less than that required to operate the loud speaker above the considerable noise in the train, except when passing through tunnels. Bicester, 53 miles, 5.10 : The strength slightly increased here, and a musical item transmitted in the Ladies' Corner, from 2 L O, came through with surprising clarity and strength. During the latter portion of the run to this point, the train continually travelled at from 75 to 80 miles per hour. King's Sutton, 63 miles : Although London was still received perfectly on the loud speaker, it was decided to change over to Birmingham. The station was easily tuned in on the telephones, and came through at excellent strength. Banbury, 67 miles : The strength of the Birmingham station on five valves only, was very good on the headphones. The loud speaker strength was also quite good, and on switching on the last valve the strength was sufficient to drown all train noises, in spite of a speed of 75 miles per hour and the empty van. Leamington, 23 miles from Birmingham : A slight decrease in strength was noticeable as the train ran into Leamington, but a considerable increase was at once apparent as it left the station, and from there to Birmingham the broadcasting was received at good loud speaker strength on the five valves. A point of interest is that the tunnel on entering Birmingham Station did not cut out the signals.

There was not at any portion of the journey any difficulty in receiving at good strength. A passing train, travelling at high speed caused a curious rushing sound in the loud speaker. There was an entire absence of atmospherics or fading due to atmospheric conditions.

On the return journey the van was shunted next to the engine of the 8 p.m. Paddington express. It was desired to see if the large body of metal caused by the engine would have any ill-effects upon the reception, and also whether the exhaust steam would cause appreciable fading. This journey being made in the dark, it was hoped that some of the more distant stations might be received. The Birmingham transmission was tuned in, and the loud speaker worked until Leamington was reached, when a change over was made to the telephones, in order that some of the more distant stations might be searched for. London was picked up at once at 8.55 p.m., approximately 80 miles away. Bournemouth and Manchester were also picked up, and all these stations were successfully received on the loud speaker when using six valves. At 9.20, whilst somewhere in the Haddenham district, Aberdeen, 350 miles away, was tuned in on the telephones, but the reception was weak. At 9.30, at Wycombe, Cardiff was strong on the loud speaker. In view of the fact that the brake van had to be cleared, the apparatus was dismantled and packed at 9.35.

During the whole run the noticeable point was the entire absence of disturbing elements and the extreme ease with which reception was obtained. The tone modulator played a valuable part in this way by clearing off any frying and spluttering that might otherwise have

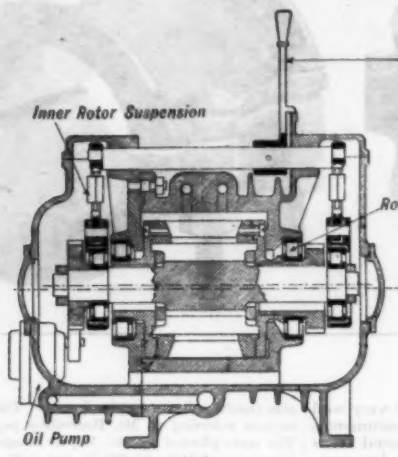


Fig.1.

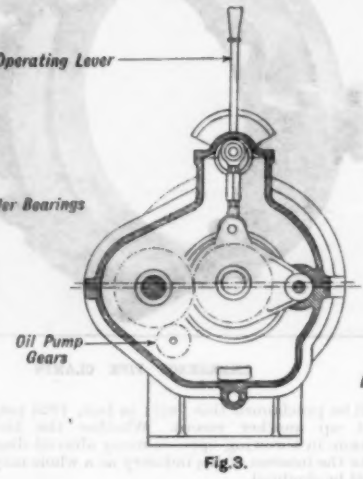


Fig.3.

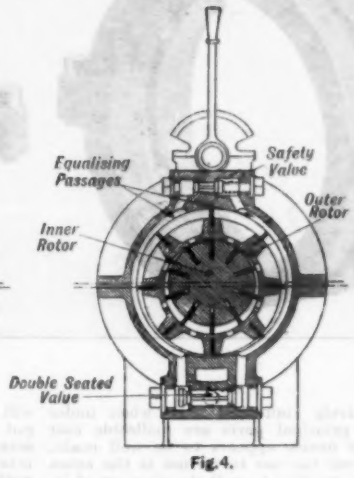


Fig.4.

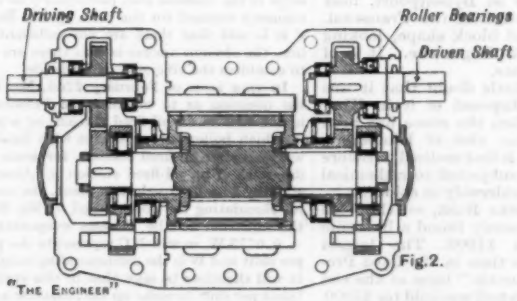


Fig.2.

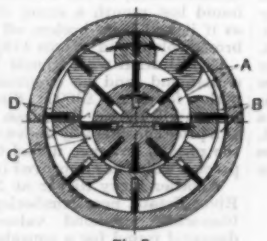


Fig.5.

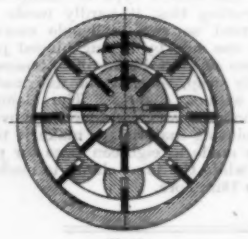


Fig.6.

Swain Sc.

THE SCHNEIDER VARIABLE SPEED GEAR

been noticeable. It would appear that telephone reception is to be preferred to loud-speaker reception on trains, as it entirely cuts off the usual train noises. It would also seem that almost any long-distance train should be able to keep in touch with at least two of the broadcasting stations pretty well throughout its journey. On the journey from London to Birmingham, there seem to be no blind spots in the route followed by the railway. The body of the engine appeared to have no appreciable effect on the results obtained. The set was working under adverse conditions, owing to the swaying of the empty van at speed, and the temporary fixing, it being simply placed on a large packing case.

The most remarkable feature of the reception was its freedom from fading and atmospherics.

To summarise the results, practically all the broadcasting stations were picked up, including such long-distance stations as Paris and Aberdeen, although the speed reached 80 miles per hour, and the noise was very great. The experiment having been made under what may be described unfavourable conditions, further trials, say, for instance, in an ordinary coach, should prove exceedingly interesting.

Australian Engineering Notes.

THE South Australian Government has accepted Messrs. Poole and Steele's tender for 600 gondola and 500 steel box railway cars. The American tender was for £1,027,000 including duty, insurance and freight, and was £92,000 lower than the lowest British offer and £288,000 less than the lowest Australian offer.

* * * * * *

THE South Australian Harbours Board, Victoria-square, Adelaide, has invited tenders, closing on May 6th, for the delivery complete, in full working order on rails at the wharf, Port Adelaide, of two 10-ton and one 15-ton travelling cranes.

* * * * * *

THE Government statistician reports remarkable manufacturing expansion in New South Wales last year. The number of factories increased from 6356 to 6698, the number of employees from 149,876 to 152,205, the added value of the raw materials used from £46,745,939 to £51,473,365, the wages paid from £26,783,242 to £27,049,475, and the value of plant and machinery from £35,229,530 to £37,515,231.

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THE imports into Australia for the first five months of the financial year exceeded the exports in value by £19,531,000.

* * * * * *

THE Federal Government has decided to make immediately a detailed survey of the Barkly Tablelands in the Northern territory with a view to the construction of 220 miles of railway to the mouth of the McArthur River.

* * * * * *

PLANS for the new railway bridge across the Murray River at Murray Bridge, estimated to cost £250,000, have been approved by the South Australian Minister of Railways, and tenders will probably be called for the work shortly. It is understood that the plans provide for a bridge entirely of steel, about 1800ft. long. The new structure, which will have a slight curve, will comprise three main spans—one of 240ft. and two of 145ft. each.

* * * * * *

A MELBOURNE company is making arrangements to grow cotton on a large area of excellent land at Roper River, in the Northern Territory. The terms of the lease provide for the cultivation of 1000 acres of cotton within three years. The company is to spend £10,000 on cotton gins, wharf and stores.

The Design of Apparatus for the Protection of Alternating-current Circuits.*

THE superiority of biased protective systems is accepted, but the objections to a more complicated relay are recognised. The author advocates the use of simple relays only, in order to restrict to a minimum the employment of moving parts associated with small amounts of power. The necessary functions peculiar to biased and certain other protective systems have led to the use of balanced beam, dynamometer, and other special forms of relay, but this paper describes how these features may be achieved with a simple relay and a static device called a "biasing transformer." Such an arrangement might consist of a pair of ring cores, as in Fig. 1 (*a*), each provided with similar operating and secondary windings connected in series; a third coil present on each core, but in one case reversed in relation to the other windings, will, if excited, have the following effect. Such E.M.F.'s as may be induced in each secondary by this third coil will not appear in the complete secondary circuit, as they will be in opposition; nevertheless, the magnetic circuits of both transformers will be excited. If such proportions be chosen that currents flowing in the restraining winding give rise to saturation of the iron, this will clearly affect the secondary current corresponding to any given operating excitation, since the secondary ampère-turns will roughly be equal to the difference between the primary and magnetising ampère-turns. Excitation of the restraining winding is capable of increasing the reluctance of the magnetic circuit to such an extent as will necessitate a very much greater operating current, in order to deliver the required secondary energy.

Whilst the above scheme is one of the most efficient forms of restraining winding, the author employs a somewhat different method presenting peculiar advantages. In lieu of the pair of cores described, a single core, having three limbs, of the form shown in Fig. 1 (*b*), is used. This shape enables two magnetic circuits to exist in the one core, each of which has a common portion as specified, and the coils may be arranged in various ways to have inductive relation with either of the magnetic circuits.

Windings appropriate to the excitation of one or other of these magnetic circuits may, however, themselves be mutually non-inductive. The restraining winding, for instance, may consist of a single coil situated on the central limb, as in Fig. 1 (*b*).

Dividing operating and secondary windings will then be employed, consisting of two coils having equal numbers of turns, each being on one of the external legs of the core. This sets up a flux, as indicated by the chain-dotted lines. A more efficient restraint, however, is given if divided restraining windings are employed, as shown in Fig. 1 (*c*). In either case the restraining windings gives rise to a saturating flux passing through the centre, as shown by the dotted lines in Fig. 1 (*c*).

This form of construction is obviously superior to the ring arrangement, since former-wound coils may be used in which laminations, conventionally jointed, may be assembled. It will be seen that the core is laminated in one plane only. A further advantage, however, is that an air gap may be provided in the restraining magnetic circuit, without reducing the unrestrained permeability of that associated with the other windings. This enables very useful restraining characteristics to be achieved.

A simple form of representation of the various windings, as shown in Fig. 2, has been adopted. The restraining winding is shown horizontally, and the operating and secondary windings, the longer and shorter respectively, of the two vertical indications.

The principal functions of the biasing transformers applied to systems of protection are overload restraint, discriminating restraint, directional discrimination, and auxiliary restraint.

A combination of biasing transformers and simple electro-magnetic relays may discharge the functions usually performed by balance-beam relays, differential induction relays, or dynamometer relays in applications of the foregoing to balanced-current protection, reverse-power apparatus, and differential forms of the latter.

In order to apply the feature of overload restraint, the operating winding will be connected so as to receive the difference current, and the restraining winding will be connected in a suitable portion of the protective secondary circuit carrying current proportional to the load on the unit protected. In the majority of differential protective circuits, this will be known as the "circulating current" circuit.

Fig. 3 shows what is probably the simplest form of protective circuit, viz., the protection of a single winding or conductor on the circulating-current system. It will be seen that the two current transformers are connected, so that current normally circulates between them when their primaries are carrying equivalent currents, but that in the event of a fault on the winding protected—to the effect that the entering and leaving currents are no longer of equal magnitude—there will appear a difference current in the relay, this being connected between equipotential points on the circulating-current circuit.

This relay will be of simple design, having no differential feature. It will therefore operate at a given value of difference or fault current, irrespective of the "through currents" which may traverse the protected circuit. This arrangement is well known, and has been widely used. It has given entire satisfaction within its sphere of utility, which is limited to cases in which no great sensitivity is aimed at and when it is possible to provide accurate balance between the current transformers, or when, alternatively, the protected plant will not be subjected to the effects of heavy external faults.

There is scope for improvement in performance in many instances, and, by the employment of the biasing transformer, this may be achieved with freedom from additional complication.

An equivalent protective circuit is outlined in Fig. 4. A relay, similar to that embodied in the scheme shown in Fig. 3, may be utilised in this circuit. In accordance with the principles indicated above, the operating winding of the biasing transformer is connected in Fig. 4, where the relay was shown in Fig. 3. The relay is excited from the biasing transformer secondary, whilst the restraining winding is included in the circulating-current connections. In order that the operating winding shall continue to receive the true difference current, the restraining winding must clearly be symmetrically disposed with regard to it, and, accordingly, one end of the former will be taken to a mid-point on the restraining winding. This modification endows the protective circuit with the characteristics shown in Fig. 5, which gives the relation between the current in the restraining winding—that is to say, the transmitted load or "through current"—and the operating excitation. In other words, it shows the difference or fault current necessary to cause the relay to trip.

Fig. 5 shows the actual magnitude of restraint that can be achieved under these conditions. The actual value attained will depend, of course, on the number of turns on the restraining coil, and a restraining action of the full extent indicated may not, in every instance, be necessary or desirable.

The use of the biasing transformer, however, renders possible the provision of a further advantageous feature not usually inherent in systems employing biased relays.

* From a paper read before the Institution of Electrical Engineers by A. S. FitzGerald.

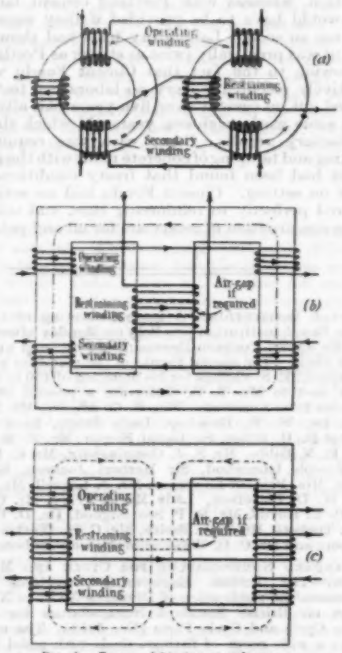


FIG. 1.—Forms of biasing transformer.

"THE ENGINEER"

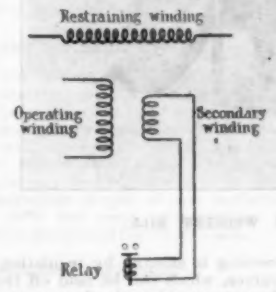


FIG. 2.—Method of indicating windings of biasing transformer.

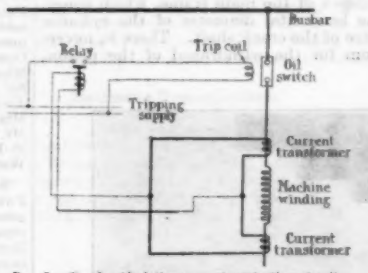


FIG. 3.—Simple circulating-current protective circuit.

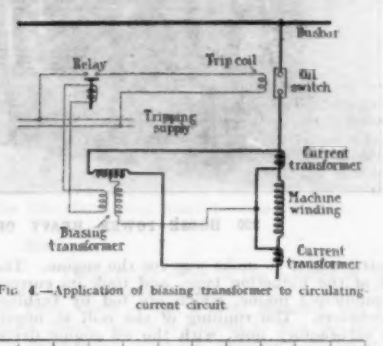


FIG. 4.—Application of biasing transformer to circulating-current circuit.

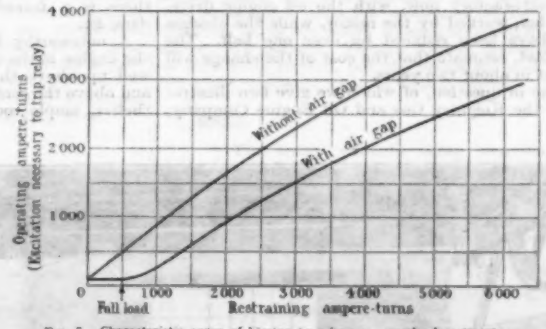


FIG. 5.—Characteristic curve of biasing transformer overload restraint

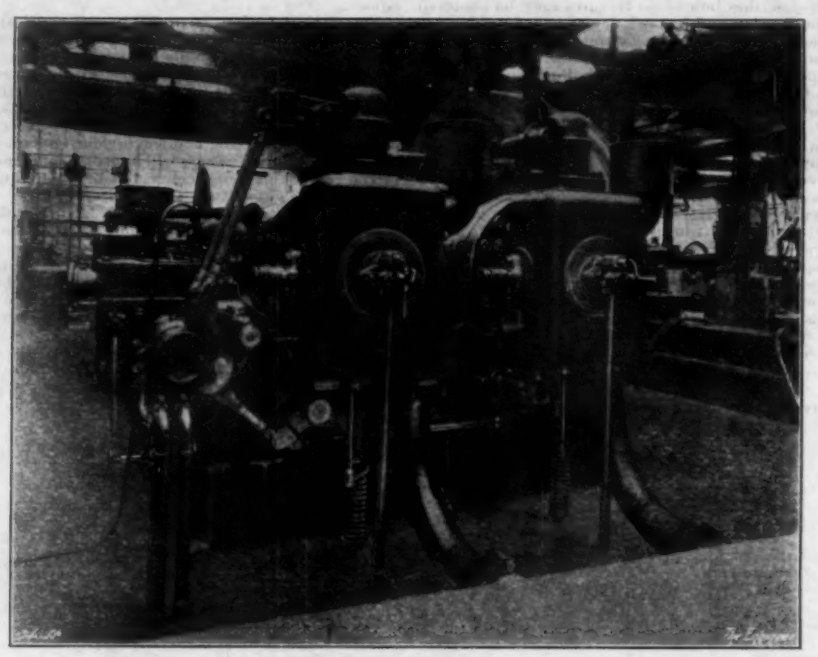
Bowes Sc

THE Metropolitan Railway Company's branch from north of Sandy Lodge to Watford has made substantial progress during the past year, and a contract for the station at Watford has been let. The line north of Harrow, as far as Rickmansworth, and the new Watford branch, will be electrified and the signalling improved.

An Oil Engine in a Woollen Mill.

The driving of a textile mill is generally considered a very severe test of the running of an engine, as the slightest variation in speed has a marked effect on the spinning of the yarn. Not only is it necessary that the governing of the engine should be very delicate, but cyclic variations, also, must be reduced to a minimum.

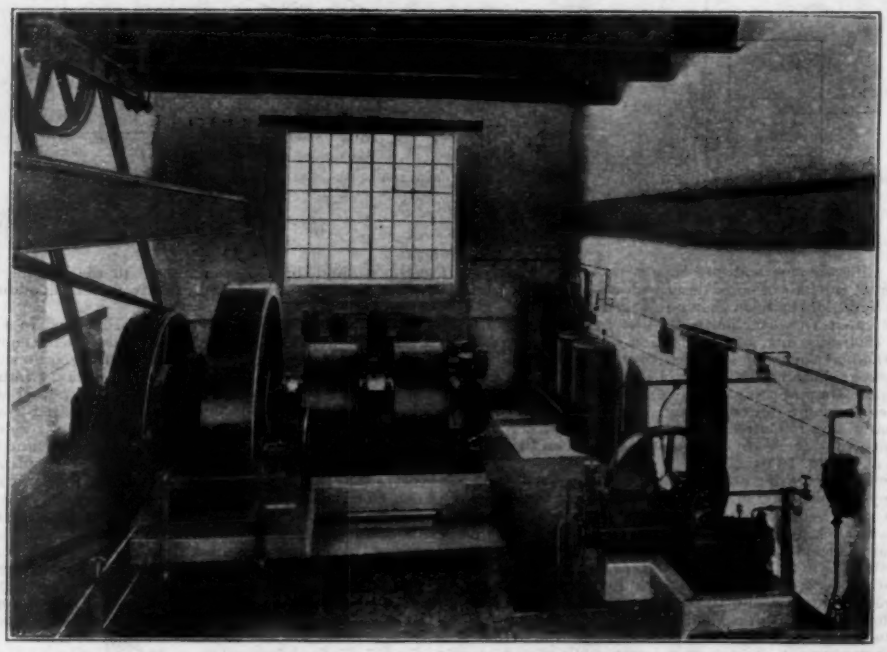
In these circumstances we were rather surprised, during a recent visit to Keighley, to find a woollen mill driven by a heavy oil engine, and this surprise was increased when we heard that the owners had taken



220 HORSE-POWER HEAVY OIL ENGINE FOR A WOOLLEN MILL

out an electric motor to make way for the engine. The motor was of the induction type, and took its current from the municipal mains, which are fed by turbine-driven alternators. The running of the mill is, nevertheless, as satisfactory now, with the oil engine drive, as it was when worked by the motor, while the charges for power have been reduced by over one half. The owners, in fact, estimate that the cost of the change will be wiped out in about two years.

The engine in question, of which we give two illustrations, is by the Keighley Gas and Oil Engine Company,



INTERIOR OF THE ENGINE ROOM IN THE MILL

of Keighley, and is rated at 220 horse-power. At the time of our visit it was loaded up to about 200 horse-power, and made no more noise than a good steam engine. It is, it will be seen, a two-cylinder engine and is of the solid injection type. The compression pressure is, however, only some 400 lb., while the fuel is injected at from 1000 lb. to 1200 lb. per square inch. The result is that no very violent stresses are set up by the explosions and the steady running already referred to is maintained. It is obvious, also, that the atomiser must produce a very effective spraying action, as the exhaust is quite invisible.

One of the outstanding features of the engine is the gear for operating the valves. There is the usual side shaft, driven off the crank shaft by skew gears, and arranged snugly alongside the bed. There are only two cams on this shaft, one for each cylinder. The method of operating the valves is plainly shown in one of the engravings, from which it will be seen that the valves of the left-hand cylinder are worked by the cam on the end of the side shaft. The exhaust valve below is moved by a link and rocking lever, while a bell crank is interposed in the linkage for the admission valve above. For the right-hand cylinder there is a similar arrangement at the cam shaft, with long links, which can be seen reaching across the engine, above and below, to the rockers of the valves.

The fuel pumps are driven directly by cams on the side shaft. Governing is effected by regulating the lift of the suction valves, which can be held off their seats by a long wedge connected with the governor. The main bearings are arranged for ring lubrication, while there is a forced sight-feed lubricator for the cylinders, &c.

A noteworthy feature in the general appearance of the engine is the depth of the main frame, which comes well up above the horizontal diameter of the cylinder and above the centre of the crank shaft. There is, nevertheless, ample room for the withdrawal of the piston, which can be run out on rollers provided for the purpose just inside the frame.

The engine at the Coney-lane Mill, in Keighley, has a 13-ton fly-wheel and drives the factory by means of ropes. There is a friction clutch to free the engine at starting; but the driver told us that he had once started up inadvertently with the clutch in. It was after the dinner hour shut down, so that the engine was slightly warm, and it picked up the load without difficulty before he had run out of compressed air. The engine is regularly started from stone cold on a Monday morning in less than a minute, but that is, of course, with the clutch open. Air at a pressure of about 250 lb. per square inch is used for starting, and is supplied by the set seen in the foreground of the view of the engine-room. This set comprises a small Keighley gas engine driving a compressor by W. H. A. Robertson and Co., of Bedford.

The makers guarantee the fuel consumption of these engines to range between 0.49 lb. and 0.42 lb. per brake horse-power per hour with oil having a calorific value of 18,500 B.Th.U. per pound. According to the log of the engine at Coney-lane Mill, the consumption has been brought down to 0.382 lb. of oil, having a specific gravity of 0.9 and a calorific value of 18,000 B.Th.U. when carrying a load of 200 horse-power.

With single cylinders these engines were made for outputs of from 11 up to 120 brake horse-power, two-cylinder engines carry on the range to 220 horse-power, while by employing four cylinders 480 horse-power is attained.

"CIMENT FONDU."

In a lecturette on "Ciment Fondu," which he delivered before the Junior Institution of Engineers, on Friday, February 22nd, Mr. J. S. Marshall, after a brief reference to the Lafarge Company which discovered this cement, said that the substance was produced during attempts to find a cement which would be impervious to water. Not only, he remarked, was such a cement produced, but the material was found to possess remarkable quick-hardening properties combined with great strength. Ciment Fondu was, it was explained, darker than Portland cement and was ground from a very hard clinker. It was burnt, not in a rotary kiln, but in a water-jacketed furnace. The cost of manufacture was, at present, two or two and a-half times that of Portland cement, but less Ciment Fondu could generally be used because of its strength. This cement reached full strength in three days, and it was on that account that the material could be used with success in the construction of roads, and that buildings could be loaded a few days after construction, whereas with Portland cement larger beams, &c., would have to be provided if they were to be put into use so soon. Laboratory tests had shown that this cement was practically twice as strong as Portland cement, but owing to the fact that Ciment Fondu was a comparatively recent discovery no laboratory tests had been carried out on cement over five years old, although there were some works eighteen years old which showed quite satisfactory results. Some care was required in the working and tamping of concrete made with the new cement, but it had been found that frosty conditions had little effect on setting. Ciment Fondu had no action on, and adhered perfectly to reinforcing bars, and could be used in the construction of reservoirs for oil and petrol.

Royal Institution.—A general meeting of the members of the Royal Institution was held on Monday afternoon, March 3rd, Sir James Crichton-Browne, treasurer and vice-president, in the chair. The special thanks of the members were returned to Major C. E. S. Phillips for his donation of £50 to the Research Fund, and to Mr. T. B. Gilley for a present of radioactive minerals from Cornwall. Miss S. G. Allport, Mr. F. H. Berryman, Dr. W. R. Bisschop, Lady Bragg, Lord Chelmsford, Colonel R. H. Elliot, Sir David Ferrier, Mr. F. M. Geoghegan, Miss E. N. Gibbs, Mr. S. J. Gunningham, Mr. C. H. Harrison, Sir Joseph Isherwood, Sir Herbert Jackson, Sir Lawrence Jones, Mrs. Pethick Lawrence, Mr. J. Layzell, Mr. C. H. Merz, Mrs. W. D. Patterson, Lady Muriel Percy, Mr. G. P. Pollitt, Mr. C. Y. Royds, Mr. B. P. Scattergood, Dr. D. H. Scott, Mr. P. F. Tuckett, Mr. T. V. Smith, Mr. C. H. Watkins, Mr. W. T. Watson, and Dr. C. H. Weiss were elected members.

Standard Nomenclature for Cycle and Motor Cycle Parts.—The British Engineering Standards Association announces the publication of Divisions XIX. to XXIII. of the report on British Standard Nomenclature for Automobile, Motor Cycle and Cycle Parts (No. 5012). The report, which covers a wide range of fittings, deals with pedal bicycles, tricycles, carrier tricycles, and motor cycles, and touches every part used in the construction of these machines. A large proportion of the thirty-five pages in the report deals with the engine cylinder, valves, crank case, timing gear, piston, connecting-rod, carburetter and ignition system of the motor cycle engine, and should be found very useful, both in the workshop and garage, as well as in the preparation of manufacturers' catalogues and stock lists. Copies may be obtained from the British Engineering Standards Association, publications department, 28, Victoria-street, London, S.W. 1, price 1s. 2d. post free.

Institute of Chemistry.—At the forty-sixth annual general meeting of the Institute of Chemistry, held at Russell-square on March 3rd, the Meldola Medal, the gift of the Maccabaeans, was presented to Mr. C. N. Hinshelwood, B.A. (Oxon.). The medal is awarded for the work of most promise published by a British chemist under thirty years of age, brought to the notice of the adjudicators during the year. Mr. A. Chaston Chapman, F.R.S., the retiring president, in his address referred to the growing activity of the Institute during his three years of office. The roll of membership had increased by 1120, and about 1000 new chemists had been absorbed into useful professional life. The new president, Professor G. G. Henderson, F.R.S., Regius Professor of Chemistry in the University of Glasgow, was formally installed. The officers, Council and Censors for 1924–25 were elected as follows:—Vice-presidents: Professor E. C. C. Baly, F.R.S., Messrs. A. Chaston Chapman, F.R.S., Andrew More, Dr. T. Slater Price, Professor Arthur Smithells, F.R.S., and Mr. E. W. Voelcker. Hon. treasurer: Mr. Patrick H. Kirkaldy. General members of Council: Mr. Leonard Archbutt, Dr. E. F. Armstrong, F.R.S., Mr. E. R. Bolton, Professor A. A. Boon, Dr. F. D. Chattaway, F.R.S., Mr. R. Leslie Collett, Dr. I. G. Colman, Mr. John Evans, Dr. R. H. Greaves, Professor A. J. Hale, Mr. G. Nevill Huntly, Professor W. H. Lewis, Mr. W. McD. Mackey, Dr. H. McCombie, Dr. R. S. Morrell, Mr. G. N. Perry, Professor J. C. Philip, F.R.S., Dr. R. H. Pickard, F.R.S., Mr. B. D. Porritt, Professor F. L. Pyman, Mr. W. D. Rogers, Mr. H. Silvester, Dr. Arthur Slator, Professor J. F. Thorpe, F.R.S., Dr. J. F. Tocher, Dr. D. F. Twiss, and Professor F. J. Wilson. District members of Council: Dr. Leonard Dobbin (Edinburgh and East of Scotland), Mr. H. J. Evans (Liverpool and North-West Coast), Dr. W. R. Fearon (Irish Free State), Dr. W. H. Gibson (Northern Ireland), Mr. C. A. F. Hastilow (Birmingham and Midlands), Mr. E. M. Hawkins (London and South-Eastern Counties), Mr. R. D. Littlefield (Bristol and South-Western Counties), Mr. S. E. Melling (Manchester and District), Dr. L. G. Paul (North-East Coast and Yorkshire), Mr. C. A. Seyler (Wales and the County of Monmouthshire), and Mr. J. H. Young (Glasgow and West of Scotland). Censors: Mr. A. Chaston Chapman, F.R.S., Sir Herbert Jackson, F.R.S., Professor G. T. Morgan, F.R.S., and Sir Robert Robertson, F.R.S.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Market Conditions.

MIDLAND iron and steel masters are experiencing an extremely difficult time, but the market tone in this area is cheerful when compared with the reported dismal conditions prevailing in some centres. Confidence even here is weak, however, and the business which is being placed is of a hand-to-mouth character. Consumers are using every endeavour to secure lower prices, but present selling rates leave such a bare margin of profit that producers cannot see their way to close with the offers which are being made. Though continental prices are a little stiffer, they are still attractive, and in view of the large amount of business going abroad merchants are in some cases offering finished steel at below makers' quotations. Ironmasters in Staffordshire are finding it difficult to realise the better prices which they have recently been getting for merchant iron and, in some cases, they have this week done business at the old figure of £12 10s. for Crown iron and £11 10s. for nut and bolt iron. Smelters adhere to recent rates for the most part, but consumers of pig iron claim to have bought this week at slightly lower rates both forge and foundry material. The fuel position is still the dominating factor in this department, and until the outlook is clearer smelters would be disinclined to accept forward business even if it were obtainable.

Staffordshire Iron.

Business is quiet in the Staffordshire finished iron trade, but makers of best iron are maintaining prices at £14 10s., and have good order books. Competition in merchant iron, however, is so severe that most makers have returned to their old quotations of £12 10s. per ton for Crown bars and £11 10s. per ton for nut and bolt qualities. Lancashire makers continue to quote nut and bolt iron at £12, but users can get all the material they require at the moment from Belgium at £8 15s. delivered in the district. After the Belgians have taken what they want the orders that remain to the Staffordshire common bar mills are few. The district, fortunately, appears to be getting a fair share of the steel re-rolling business.

Pig Iron.

The pig iron situation continues to be dominated by the coke market. Furnace cokes are still difficult to get on any practicable terms, but the price has eased slightly this week. Coke prices will be due for reconsideration shortly, and smelters are exerting strong pressure to obtain concessions. The demand for pig iron has become so quiet that makers are getting more nervous as to the disposal of their output. Moderate sales of forge material have been made to Staffordshire ironworks this week at slightly lower prices, and Northamptonshire makers have in some cases accepted 1s. per ton below last week's prices. Derbyshire smelters, however, hold out for their quoted price, and the same applies to North Staffordshire concerns. Political and labour uncertainties continue unfavourably to affect business generally. Makers of pig iron are not disposed to book forward, even if they had the opportunity, in view of the possibilities of mining troubles endangering fuel supplies when the present wages agreement expires. Recent reductions in Cleveland pig iron prices have brought the standard brand of No. 3 down to the Derbyshire figure of £4 15s., depriving the Midland makers of an advantage in competition, which they have held for several months past, in certain areas served alike by North-Eastern and Midland brands. It is considered that if blast-furnacemen could see any reasonable possibility of re-animating the market by reducing prices they would probably be prepared to do so and rely upon the larger turnover to give them a profit. They see no likelihood of such a result however.

Steel.

Very little new business in either finished or semi-finished steel is being placed, and values are on the weak side. A few orders for railway bridges, which are the subject of negotiation, may be placed shortly. But the demand for constructional steel is small, partly on account of uncertainties in connection with building operations, and partly because of the low continental prices. In this district a large mill has been started which will add to the output of its owners by, it is stated, about 1000 tons of finished material per week. In spite of depressing circumstances, mill improvements are constantly in progress. The steadiest department of the steel market is that concerned with plates. There is a well-sustained demand for thin plates. It is reported that in several instances this week steel makers have shaded the nominal quotations for sections and bars. Angles and joints are still quoted £10 per ton and tees £11, while small steel bars range from £10 5s. to £11, non-associated houses quoting the lower figure. Billet makers, who have picked up some chance business lately owing to the intermission of continental supplies, quote round about £8, some sellers accepting a little less for a good order and others requiring a little more. Belgian quotations continue substantially below those of native makers, though during the past week quotations for Belgian steel have advanced from 2s. 6d. to 5s. per ton. For small billets about £6 17s. 6d. is the general quotation. The uncertainty of delivery tends to restrict the placing of orders abroad by those who require early supplies. Local steel makers can generally give quick delivery.

Galvanised Sheets.

Galvanised sheet prices are irregular. £18 10s. is the figure which nominally rules for 24-gauge corrugated sheets, but some mills shade this price when it suits their purpose. Black sheets are in fairly good demand and values are firm.

Scrap.

Steel scrap continues weak, and there is now no difficulty in securing adequate supplies at £4 10s. per ton, while in some cases consumers state they have been able to place business at £4 7s. 6d. Wrought iron scrap, on the other hand, is in good demand, realising, in some instances, as much as £5 5s. per ton.

Increase in Miners' Wages.

Miners in the Cannock Chase coalfield are to receive an increase in wages during the months of March and April of 2d. per day. This increase follows upon an advance of 7d. per day in November and December, and brings the minimum wage of stallmen to 10s. 5d. per day, compared with 10s. 3d. in January and February. It is not surprising, therefore, to find that considerable uneasiness exists amongst miners in this coalfield concerning the possibility of the present wages agreement being scrapped. They are in an exceptionally advantageous position under the present wage agreement, in consequence of being included in the Eastern Federated area, and their present good wages are due to their being linked with a district like Yorkshire, which has of late been exporting a lot of coal. Whilst South Staffordshire, East Worcestershire, Shropshire, North Staffordshire and other districts were last month receiving only 32 per cent. on the 1914 wage rates, Cannock Chase miners were receiving 55.66 per cent. over the basis, and that figure has now been raised to 58.47.

£42,000 for Plant.

It is of interest to engineers in this district that the East Worcestershire Waterworks Company is in need of increased plant, and that it has been decided to sink an additional borehole at Washingstocks, which, with additional trunk and pumping mains, is estimated to cost about £42,000.

Coventry Motor Industry.

The improvement in the Coventry motor engineering industry is well maintained, although the demands from export markets are still far from satisfactory. The large extensions now being carried out at one of the leading factories will, it is hoped, be completed shortly and work found for 300 or 400 hands. The motor car factories are working day and night, and it is estimated that the present aggregate output of cars in Coventry is not far short of 2000 per week. Competition is keen, but a healthy tone dominates the whole trade.

Black Country Engineering.

Black Country engineering firms are in many instances finding a distinct improvement in business. Electrical-power machine constructors report a distinct hardening of business, although prices are unaffected. The export branch is better, good business being done with India and New Zealand. Boilermakers report that orders continue to be placed in spasmodic fashion, although there is sufficient to keep a full staff employed in some big concerns. Competition is still very keen.

Decline in Unemployment.

The decline in unemployment in the Midlands continues. The latest returns give the figure as 139,960, whereas a week ago the total was 142,042, and that figure was 5288 lower than the week before. Unemployment is distributed as follows:—Men, 99,956; boys, 2624; women, 33,486; and girls, 3894

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Conditions.

THE recent improvement in non-ferrous metals is satisfactory to a certain extent, but one fears that it is not indicative of any general improvement in trade conditions. The markets here, in spite of advances in copper, tin and lead, remain dull and dispirited, and the attendance at the meetings of the trade held at the Manchester Exchange show clearly that no large business is passing, and, moreover, that it is not expected. The announcement of the very large expenditure to be incurred by the London, Midland and Scottish Railway group is certainly a promise for the future, and may do something to brighten trade later on in the year, while the work on wagon building in Lancashire and in the Midlands has already done something to increase the consumption of finished iron, but the iron and metal trades of this country cannot exist upon the home trade alone, and just now there seems to be imminent danger that our export trade may diminish and dwindle unless and until the British producer can reduce the costs of his productions.

Metals.

The copper market has shown some strength lately, and it is to be noted that the set-back after the previous rise did not go nearly so far as had been the case on former occasions. This would seem to suggest that we are coming near the time when a higher level of prices will prevail for standard and refined copper. Of course, it is universally admitted that copper had been depressed until its relationship with iron and all the other metals was distorted. There is ample room for a big advance in copper so soon as the market becomes satisfied that the monthly output is not too large for the world's requirements. A revival of copper exports to Germany and Russia, which now seems within the bounds of possibility, would make a great difference in the situation; and the market is now well worth watching, and probably engineers would not be unwise to see that their stocks of metal were sufficient to last them for some time. Already some attempt is being made in the United States to reduce the output of the metal, so as to effect a balance between production and consumption. Sales of copper have recently been made to Germany, and it seems possible that the consumption in that country will begin to approach nearer to the normal. It is true that the engineering demand for copper in this country is not yet good, but it is said to be better than it was. In the scrap market for copper, gun-metal and brass there has also been some movement, and the dealers seem more willing to buy. The higher price of spelter is affecting the prices given for old yellow brass, and people are beginning to realise the absurdity of giving less than the value of spelter for good heavy scrap brass. Tin has again shown a good deal of strength. Some time ago I suggested that the upward movement in tin prices might not be permanently arrested before the £300 level was reached; and that now appears quite probable. The enormous increase in the consumption of tin for tin-plate making is a feature which cannot be ignored. The further advance in the price of lead is not surprising when one considers the conditions. Lead production is not increasing to any extent; but modern conditions require very much more, and if Russia should come into the market there will be little chance of cheaper metal for some time to come. Spelter has been firm, but the price is now on a level with foreign lead. It is very unusual to have lead and spelter at the same price, and nothing could more emphatically illustrate the great change which has come over the conditions relating to the consumption and production of the former metal. There seems to be some idea that the alterations in the Reparations Recovery Act, bringing the levy on German goods to 5 per cent., may result in the export of more German spelter to this country; but Germany has not now any very large spare tonnage of spelter. The demand from galvanisers here has not been very large of late; but the galvanised sheet business is good, and it seems probable that buying will soon recommence on a larger scale. The general position of the spelter market, therefore, seems to be sound enough in spite of the fact that the rise since the beginning of the year amounts to £5 per ton.

Pig Iron.

The markets in Manchester for pig iron remain very dull and quiet. There is no indication yet that the Derbyshire makers are prepared to reduce their prices, and perhaps they are not yet very hungry for new orders; but if the very small buying continues for another fortnight it seems probable that something will have to be done either to increase the sales or to reduce the output. The Cleveland iron market remains weak.

Steel.

There is no relief in the dulness of the market for all kinds of manufactured steel, except thin sheets. For these there is still a good demand, but for plates, angles, joists, &c., it is difficult to find any new business. The Association price for joists and angles is still £10, and from 5s. to 10s. below is being accepted by merchants and outside makers. Foreign steel is, perhaps, not quite so plentifully offered, but the prices are still temptingly low when compared with the British prices.

Scrap.

For heavy wrought scrap iron there is still quite a good demand at £5 to £5 5s. per ton delivered; but dealers are now beginning to be stiffer and think that there is a possibility of obtaining more money. The demand for foundry scrap is said to be a little better than it was; but good broken machinery iron can still be bought at 90s. per ton delivered. Steel scrap for melting purposes is weaker than ever, and when dealers buy in Lancashire they cannot afford to pay more than about 80s. per ton on trucks.

Engineers, Inventions and Patents.

The members of the Institution of Mechanical Engineers who were present at the meeting of the North-Western Branch on Thursday, the 28th ult., to hear Mr. E. C. R. Marks' paper on "Engineers, Inventions and Patents," went home highly pleased with the manner in which the author handled what, in the hands of many persons, would have proved a dreadfully dry subject. Mr. Marks was, I believe, prompted to write his paper in reply to a leading article in THE ENGINEER some time ago, in which it was advocated that the examiners at the Patent Office should be permitted to exercise the right to refuse the granting of Letters Patent for certain alleged inventions, and although he expressed his disagreement with the suggestion, he had to admit that many patents are obtained every year for inventions, or "so-called inventions of little or no value." But he said that to give the Patent Office summary powers of rejection would not materially lower the number of such applicants. In the United States, where such powers are enjoyed, any little advantage which such a system might possess was, Mr. Marks said, far outweighed by its disadvantages. Time and money had to be expended in combating the arbitrary opinion of an examiner, and when that had been accomplished there was no guarantee as to the validity of a patent. Mr. Marks created a good deal of amusement among his audience by his "asides," which embraced many witty sayings, and his remarks on the concrete examples which he introduced on the recommendation of the "reading committee" to illustrate his arguments, formed one of the best features of a really enjoyable address.

Express Motor Omnibuses for Manchester.

An interesting innovation is about to be introduced in Manchester by the Tramways Committee on the recommendation of Mr. H. Mattinson, the tramways engineer and manager. It is an express service of motor omnibuses, which will run on one of the same routes as the existing tramcars, but will only make a very limited number of stops to pick up and put down passengers. The route chosen is from Didsbury to St. Peter's-square, and the fares will be somewhat higher than those charged

on the tramcars. The experiment will be watched with much interest by all who have to deal with street passenger traffic, and will be welcomed by the long-distance riders. The vehicles employed will be of the single-deck type.

Modern Foundry Practice.

On Wednesday, the 27th ult., Mr. Percy Pritchard read a paper on "Modern Foundry Practice" before the Manchester Centre of the Institution of Automobile Engineers. After describing the general principles of founding, including moulding machines, the author referred in detail to the manufacture of aluminium, sand and die-castings, iron castings, centrifugal castings, malleable iron castings and mild steel castings. Then followed some notes as to how some of the difficulties encountered in foundry work could be overcome by alteration in the design of the parts. The author then emphasised the necessity for consultation between foundry and designer, and made the suggestion that young automobile engineers possessing sound knowledge and acquainted with modern foundry practice should be encouraged to take up the profession of foundry engineers, a branch in which there is great demand and no supply.

A Prosperous Manchester Firm.

Presiding in the absence of the chairman, Mr. Loris E. Mather, at a meeting of shareholders in Mather and Platt, Limited, on the 28th ult., Mr. John Platt said that every section of the firm's activities had contributed to the success of its operations during the year, which had resulted in the earning of a net profit of £325,290. In the textile branch there had been an increased volume of home business, in the fire engineering department new forms of application and fresh fields of interest had been found, while the electrical department had continued to expand. Mr. Platt said that during 1923 the electrical department had secured more orders for machines than in any previous year during its forty years' existence. He also referred to the large contracts which the firm is executing for pumping plants in India, Newfoundland, Australia and South Africa. The company, he added, had been fortunate in their appointment of Major Arthur Roberts, M.C., M.Sc., as works manager in place of the late Mr. Edwin Buckley. Major Roberts was trained in Mather and Platt's works and abroad, and graduated at Manchester University.

BARROW-IN-FURNESS.

Hematite.

Signs are still wanting to show that the expected revival in the hematite pig iron trade has come. The various set-backs in the way of labour troubles have, no doubt, contributed to the present quietness, but it would not be correct to attribute the whole cause to those unfortunate happenings. It is realised that the demand for mixed numbers will increase, but it is a matter of waiting for the demand to come along. Certain well-known customers are in for brisker periods in the early future, but they are still inclined to order only what is required for immediate use, there being a distinct disinclination to place orders for forward delivery. The continental trade is small, but the American business is likely to improve as, no doubt, the direct services from Barrow to New York will encourage this trade. At present it does not bulk very largely. There is no increase in the number of furnaces yet, and the fact that the two which were damped down as a result of the railway strike are still out of action will give a pretty fair idea of the state of the trade at present. Prices do not show any tendency to come down to any appreciable extent.

Iron Ore.

The condition of the local iron ore trade is simply a reflection of the iron trade. None of the mines is what one might call active. Those which are bringing up the most are situated in Cumberland, but as the number of furnaces are so restricted the demand is small all round. There is a certain amount being shipped to other British ports, but it does not amount to much. The trade in foreign ore is not brisk, although the shipments recently have been above the average. It means that the greater bulk of Spanish ore which has arrived recently will go into stock.

Steel.

The steel trade remains about the same, the Barrow works being the best employed. The rail and merchants mill are still at work, and the hoop and small section mills are fairly well off for orders. The orders held for rails are not heavy, but it is hoped that more will be secured to keep the mill going. The competition *is* keen.

Shipbuilding and Engineering.

Messrs. Vickers keep booking orders on the engineering side for various specialities. This side of Vickers activity is developing considerably, and is leading to much employment in the district. There are no fresh shipbuilding orders to report at the moment, but the prospect is by no means bad, as will be seen in the early future.

SHEFFIELD.

(From our own Correspondent.)

Uneven Conditions in the Steel Trade.

THE state of the steel trade in Sheffield continues to give only partial satisfaction. While some branches are enjoying a very fair measure of employment, others are painfully slow in recovering from the slump, and have lately shown a slackening tendency. The demands of the railway services are keeping some departments busily engaged. Many of the wagon shops are on full time, while in the axle, tire, spring and buffer departments there is a steady increase of orders week by week. The motor trade continues to send forward good orders for steel, while a satisfactory inquiry for cold rolled strips, combined iron and steel, wire and tools, is maintained. For pig iron, scrap, low-grade steels, and ferro-alloys, however, the demand has fallen off. The crucible steel department, though much better off than it was a year or two ago, fails to register the advance that is desired. The sales of the best quality tool steels and tools to France and Belgium have been further curtailed by the weakening of the exchanges, and the European markets generally are quite unable to buy on anything like a normal scale. This factor makes a vast difference to the prosperity of one of the most important branches of the city's trade. On the other hand, an expanding export demand is reported for machine knives and some classes of finished tools. A very good order from Japan, for circular wood-cutting saws, is keeping one firm at work up to its full capacity in this section. Makers of hacksaws have a large amount of work on hand, while for edge and farm tools there is a moderate demand, on both home and foreign account. A fair regularity of working is being maintained by the rolling mills.

Cutlery and Plate.

The general tone of these trades is unsatisfactory, although there are departments which are busy. A considerable output of stainless cutlery is maintained, but the sales are below those of last year. Trade in silver and plated hollowware has been sluggish for a considerable time, and shows no improvement. For spoons and forks, however, there is a ready demand on a large scale. Perhaps the busiest people in the cutlery trade are a few firms who have set themselves out to specialise on certain classes of goods in order to compete with Germany in both price and quality. These firms are receiving many good orders from a number of markets. In other respects, the decrease of imports from Germany has not brought a great deal of business to Sheffield, although there is a better demand for scissors, and the razor branch is less depressed than it has been since the end of the war.

Safety Razor Blades.

The fact that a number of safety razor blades, exported from Sheffield to the United States, have been returned by the Customs authorities on the ground that they did not comply with the regulations as to marking is significant. Sheffield is following in the wake of America in the manufacture of wafer blades. These articles were introduced by the Americans, but Sheffield firms took up their production about a couple of years ago, and have had great success with them, sending large and increasing quantities to Canada, France, and other markets overseas. The Sheffield blades have obtained a high reputation for excellence and efficiency, and they have the additional recommendation of being cheaper than the United States article. The mere fact that Sheffield is exporting blades to the United States is interesting in itself, and the action taken by the Customs authorities across the Atlantic makes the matter more important. The ground on which the blades were returned was that the mark of origin had been etched instead of die sunk. The striking fact about the matter is that the blades are so thin that the die sinking would ruin them. At the meeting of the Sheffield Chamber of Commerce, at which the matter was reported last week, it was urged that the United States authorities were exceeding their powers. The United States Tariff Act, 1922, provides that articles capable of being marked without injury at the time of manufacture must be marked with the name of the country of origin. It is, therefore, contended that the regulations as to die sinking are outside the scope of the Act, inasmuch as die sinking would render the goods useless. The Chamber decided to make representations to the Board of Trade. During the same week that this point arose, a German engineer visited Sheffield with a set of machines for producing safety razor blades more economically than the present process. Only a small capital outlay is needed, and it is claimed that the plant, with the attention of only two girls, will produce from the raw material 250 grosses of ground and finished blades per day of twelve hours at an extremely low cost. The plant created a favourable impression on several local manufacturers, and there is a likelihood of its adoption.

New Processes.

A good deal of interest is being taken in Sheffield in the latest news with regard to chromium plating. I have in the past referred to this new development, which has for its object the imparting of a stainless surface to metals. Chromium is the active ingredient which produces stainlessness in steel and iron, and the claim is that, by its deposition on the surface of articles, they can be made stainless at a much less cost than that of the all-stainless variety. The process is declared to have vast possibilities. The latest news is that it is to be carried out on a commercial scale. A private company has been established, with a capital of £30,000; new works have been purchased, and plant is to be installed to develop the discovery fully. Another invention in which Sheffield is interested is the manufacture of Belais gold. This is an American process, by which gold is alloyed, not with the mixture of silver and copper generally employed, but with a new and whiter metal. The finished product cannot, it is said, be distinguished by the eye from platinum, and it is being brought out as a substitute for that metal in the manufacture of watch cases, rings, chains, and other articles of jewellery. Platinum jewellery has enjoyed great popularity for some years, especially in America, but the metal is scarce and very dear, and Belais gold costs only a quarter of its price. The patent rights in Belais gold for this country have been acquired by the Sheffield Smelting Company.

An Electric Plant Order.

A good order which has come to Sheffield during the week is for plant for the extension of the electric lighting of the Borough of Fulham. The order, which will include two 6000-kilowatt turbo-alternators and the entire building and equipment, has been secured by Vickers Limited, at a price of £131,000. This was not the lowest offer, as a Swiss firm had submitted a tender of £12,000 less. The proposal to accept Messrs. Vickers' tender, however, received the approval of all sections of the Fulham Borough Council. The contract provided that every part of the plant was to be of guaranteed British manufacture.

Proposed New Railway.

A report which has been made public during the past week, to the effect that the London and North-Eastern Railway Company has under consideration the construction of a new railway from Moss to Bawtry, is of much interest to the West Riding, and particularly to the Doncaster district. The object is to provide an alternative route to the main line of the Great Northern section, running through Doncaster Station. The station is at present a very busy one, and frequently congested. Its drawback is that it has only a very narrow entrance at the east end. Three lines run into it—the through main track, the West Riding junction line, and the Hull line—and they all have to pass over the narrow Marsh Gate Bridge on their way in. The greatly increased quantity of mineral traffic, consequent upon the extensive colliery developments of recent years, has accentuated the difficulty. Some years ago the Great Central Railway Company constructed an avoiding line, which enabled the Sheffield and Dearne Valley mineral traffic to be diverted near Hexthorpe, and this has proved very useful. The new line which is now proposed will be some 20 miles long, and will enable through trains journeying north and south, particularly the East Coast Scottish expresses, to pass through the Doncaster area without danger of the delays which, at present, cannot always be avoided. The distance will also be shortened by about three or four miles.

Engineering Works in Derbyshire.

Among the bridge improvements which the Derbyshire County Council has in contemplation is not only that at Baslow, to which I have previously referred, but also one at Rowsley, a few miles away. The present stone bridge, which is some 300 years old, is to be widened, on the side facing up the river Derwent, to a total of 40ft. Concrete and steel will be used. The cost is estimated at about £12,000, half of which will be borne by the Ministry of Transport. Another interesting item from Derbyshire relates to colliery workings near New Mills. Mr. J. W. Swindells, of that town, has for two or three years been working the Arden Colliery, at Birch Vale, from which there is now a considerable output of coal. He is now opening out a colliery at Strines, between New Mills and Marple. A drive has been made into the side of the hill, and last week about 100 tons of coal were won. A tramway is now being constructed from the mine to the main road, and an aerial ropeway is to be installed.

Various Schemes.

An agitation is afoot at Bridlington for the construction of a new sea wall on the south side of the harbour and the deepening of the harbour. The Town Council and the Harbour Commissioners have the matter in hand, and it is hoped that before long a scheme will be approved and will receive the assistance of the Ministry of Agriculture and Fisheries. The estimated cost of the construction of the first section of the wall is £57,000, but it is hoped that the silt from the harbour and the harbour entrance may be used for "backing," in which case the outlay would be reduced by £3000. At Greasborough, near Rotherham, the Urban Council has decided to ask the Ministry of Health to sanction a loan of £6800 for works in connection with the provision of the new sewage works to serve the village and also the Manghan area. In the Doncaster Rural District boring is proceeding in connection with a water supply scheme for Austerfield, and the borehole has now reached a depth of 292ft.

NORTH OF ENGLAND.

(From our own Correspondent.)

A Gloomy Trade Position.

THE prolongation of the period of inactivity which commenced with the dawn of the New Year, and which was aggravated by the railway and dock strikes, has created a feeling of pessimism as to the immediate industrial outlook in the North of England. The position in the Cleveland pig iron trade is causing considerable anxiety. Last month the exports were the lowest recorded since November, 1921. The dockers' strike was a contributory cause. The chief reason, however, is that Cleveland producers have virtually lost their oversees markets. The fall of the franc, and the consequent low cost of production in France and Belgium, has enabled continental producers to cut them out, and even the home market has not been immune from their attacks. By ruthless price-cutting Cleveland producers have, to some extent, regained their position in the home market, but they cannot compete on the Continent, and without foreign trade Cleveland cannot find full employment for its plant and its workers. The result is that three blast-furnaces have been put out of operation, leaving only 46 in blast on the North-East Coast, compared with a pre-war average of 72.

Iron and Steel Exports.

The shipments of pig iron from the Cleveland district during February totalled only 16,471 tons, compared with 41,270 tons in January. Coastwise shipments fell from 14,160 tons to 4740 tons, and foreign shipments from 27,110 tons to 11,731 tons. America was the largest customer with 3925 tons, whilst Belgium received 2009 tons, France 1450 tons, and Germany 1120 tons. There

was, however, an improved export of manufactured iron and steel, the February total, in spite of the dockers' strike, being 62,199 tons, as against 54,529 tons in January. To India and Ceylon alone no less than 25,065 tons were shipped, whilst an export of 8013 tons to Egypt marked a steady development of trade with that country. Only 5324 tons went to South and East Africa, compared with 8073 tons in January; but the Australia and New Zealand total was 7891 tons, compared with 3800 tons in January.

Cleveland Iron Market.

A slightly improved tone has been noticeable on the Cleveland pig market this week. Prices have again fallen, and there now seems to be a fairly well-grounded opinion that bottom has been touched. Buyers are certainly showing more interest in the market, and if they can be convinced that nothing further is to be gained by waiting, business is likely to show a speedy expansion, as it is known that the bulk of the home consumers have been working from hand to mouth, and have very depleted stocks of iron. The last few days have seen a substantial number of orders placed, and further inquiries are circulating. Only small parcels are being sold for export, but it is significant that numbers of inquiries are now coming in from continental consumers, who are evidently experiencing difficulty in getting delivery of foreign iron. French and Belgian prices are still well below Cleveland No. 3, continental foundry iron being quoted about 85s. per ton f.o.b. Antwerp, and that is a price with which Cleveland cannot compete; but French makers are stated to be unable to take any more orders. No. 3 G.M.B. Cleveland pig iron is now quoted at 93s. per ton, and this price might be shaded with the offer of a substantial order. No. 1 is put at 96s., No. 4 foundry at 92s., and No. 4 forge at 91s.

Hematite Pig Iron.

The East Coast hematite pig iron trade presents no new feature of moment. Makers are still reluctant to cut prices, and as production is being curtailed they, too, are hoping that the decline has reached its limit. No difficulty, however, is experienced in placing orders for mixed numbers at 100s., and No. 1 at 101s. per ton, and, possibly, both figures might be shaded.

Ironmaking Materials.

The foreign ore trade is in a lifeless state. Not only are consumers absolutely refusing to consider new business, but are seeking to delay deliveries under contract. Freights, however, are rising, so that price-cutting is out of the question, and best Rubio ore remains nominally at 24s. per ton c.i.f. Tees. Coke prices are weak, and a reliable figure is difficult to fix; but buyers profess to be able to purchase good Durham furnace coke at 30s. per ton delivered at the works.

Manufactured Iron and Steel.

Moderately active conditions prevail in the manufactured iron and steel trade. Some of the shipyards are well employed and are sending out a regular flow of specifications. There is also a fair demand for constructional steel, and the galvanised sheet makers are very busy. But there is nothing like a spurt in any branch of the trade, and there is keen competition for foreign orders, for which there are no fixed prices. Quotations to home consumers are unchanged.

The Coal Trade.

The Northern coal trade has assumed a very strong position, and all qualities are moving upward in price. The accumulated orders through the dockers' strike are all to be filled. The delayed tonnage is arriving freely, and the spot pressure for coals is very insistent. Neither direct producer nor second-hand holder has any substantial parcel for disposal, and hence, for early delivery, all classes command good prices, and the forward outlook is strengthened by consumers' fears that a miners' stoppage might take place within a few weeks, and they are, consequently, inclined to stock to their utmost extent. Fitters, however, are so fully sold that it is difficult to bring any substantial forward booking for immediate deliveries without increasing the normal values, and this is occurring. The collieries are well booked, and there is substantial new business offered by merchants, so that prices are being forced upward. Continental buyers are holding back new business in the endeavour to get supplies forwarded in advance of normal time, but the limited quantity of coal available for over the next two months is all in favour of holders securing substantial prices. Best steams are a good trade, in addition to being a speculative trade for early delivery, and from 26s. 6d. to 27s. is freely asked, and transactions have taken place at average figures. There is also an improved tone in gas coals and higher prices are quoted. A better trade is reported for coke, and stocks are being reduced.

SCOTLAND.

(From our own Correspondent.)

Clyde Shipbuilding.

IMPROVEMENT in the shipbuilding industry is very slow and the present situation gives little cause for satisfaction. The returns for January of this year appeared to indicate progress, but the comparatively good total of tonnage launched was almost entirely due to the completion of vessels retarded by the dispute at the shipyards last year. A number of new contracts have been reported since the beginning of this year, but few, if any, new keels have been laid down, and the number of men employed is limited. The costs of output continue high and the rate of production is likely to be retarded accordingly. In this respect the situation is further affected by the application for a wages advance of 10s. per week made on behalf of the shipyard union of the Federation of the Engineering and Shipbuilding Trades. Builders find great difficulty in securing new contracts, and the month of February was a very lean one in this connection. The tonnage launched during February amounted to thirteen vessels of 10,607 tonnage, which is less than one-third of the usual output for that month. The only vessel of note was the Hardanger, cargo steamer, 4000 tons, built by Lithgows, Limited, Port Glasgow, for Norwegian owners. New contracts announced include one for Australian owners for a vessel of 5500 tons deadweight.

Manufacture of Belgian Cement.

It has been reported that William Baird and Co., Limited, Gartsherrie, have secured the sole rights to manufacture in this country the "Tilleur" brand of Belgian cement. Further developments in the cement trade in this country are in course of negotiation.

Small Demand for Steel and Iron.

So far as regards new business the situation in the steel trade is unsatisfactory. Only immediate requirements are being considered, and they are very limited. Orders from shipbuilders are far below expectations, and foreign inquiries are meagre at present. Makers have a fair tonnage on hand, but the outlook is unpromising. Specifications for plates are particularly scarce. Producers anticipate continued severe competition from continental sources, and view with considerable apprehension the reduction of the reparations levy on German goods. Makers of steel sheets and producers of bar iron have some good orders on hand, but are not booking much new tonnage. The pig iron trade is very quiet. Local consumers are apparently well covered meantime, and, despite the easier tendency of foundry qualities, very little fresh buying is reported. Nevertheless, it has been mentioned that additional furnaces may be put into blast.

Coal

There is little change in the position of the Scotch coal trade. West of Scotland shipments were seriously interfered with during the dockers' strike, and the collieries have had a big leeway to make up. Consequently they have had little fuel to offer for sale for prompt delivery. Shipments from the East Coast were not interrupted to any extent, but even with supplies available business is slow. Buyers adhere to their policy of caution with regard to forward negotiations, and while washed materials have a fair inquiry, the general turnover is very moderate. A lack of empty wagons and the delay of boats owing to stormy weather have curtailed shipments, and the returns for the past week only amounted to 256,691 tons, compared with 329,041 tons in the same week last year. Prices for export are almost unchanged.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

THE conditions in the steam coal trade are improving. Coal owners have had a bad time during the past week or so, but the position is brightening up. Collieries, with few exceptions, have been able to maintain work without interruption owing to the shortage of wagons brought about through the accumulation of stocks as the result of the scarcity of ready tonnage. At the end of last week and this week chartering has been on an active scale, and though there are still idle berths at some of the principal docks in this district the probability is that next week the tonnage situation will be much better and that there will be a renewal of loading pressure. Already the weak spots in the coal market are being eliminated gradually, and whereas colliery salesmen recently were only too ready to make concessions for prompt orders, now the position is that they are stiffening their ideas and will not look at further business unless they can secure good prices. In some instances collieries are not likely to have coals to offer for the remainder of this month, provided their tonnage comes up to time. It will be no surprise if the second half of this month displays a very firm tone, as some heavy shipments have to be made, and increasing uneasiness is being felt regarding the possibility of trouble with the miners next month. Many consumers abroad are showing a disposition to take additional supplies of coal in case there is a stoppage in the coalfield, and these coals will be wanted during the latter half of this month and the first half of April. There are, however, some inquiries in the market for coals for delivery from now up to September, one of them being on French railway account for 20,000 tons of large, while it is reported that prices are also wanted for over 100,000 tons of good large coals for the Roumanian railways. In regard to patent fuel it is understood that the Algerian State Railways recently bought 70,000 tons of ordinary Cardiff brands of fuel at prices ranging from 29s. 6d. to 31s. 6d. per ton f.o.b.

Miners' Demands.

There is no doubt that all concerned in the coal trade would prefer to have more visible evidence that something is being done in order to get to grips respecting the miners' demands, and that some progress was being made towards a settlement. It is felt that time is getting on, and all would desire that an eleventh-hour settlement should be avoided if it is at all possible, because driving matters to the last minute are highly detrimental to the interests of the trade. It is not suggested that nothing is being done, but it is thought that the machinery is moving slowly. There is to be a miners' conference at Cardiff on Monday next, and according to Mr. A. J. Cook, who has been selected as the South Wales candidate for the position of Secretary to the Miners' Federation of Great Britain, it will be proposed at that conference that a demand shall be made in the new agreement for a percentage increase equal to the increased cost of living upon the present standard rate. In round figures the increase in the cost of living was, he said, about 80 per cent., which would mean that they would demand for the lower-paid men over twenty-one years of age 9s. 7d. per day, and for the skilled collier on the minimum wage 13s. 2d. per day. He contended that no one could charge the Miners' Executive with making exorbitant demands. Having made them they were determined to set up the necessary machinery to fight for them if necessary.

South Wales Wage Rate.

The fact that the wage rate for the South Wales miners is to remain on the minimum for this month and next will not sweeten the temper of the extremist section of the leaders in this district. According to Mr. Findlay A. Gibson, the certificate of the joint accountants for the months of November and December last shows that after allowing for standard wages, other costs and standard profits, there is available a surplus of £653,089, compared with a surplus under the previous audit of £959,933. This surplus is only sufficient to pay a general wage rate of 20.95 per cent. on the 1915 standard rates. The owners are, however, under obligation to pay the minimum wage, and to fulfil that obligation they will have to forfeit not only the whole of their prescribed 17 per cent. share of the surplus, but also £156,000 of their standard profits. Under the audit for the September and October months, the percentage certified was 26.93 per cent. on the 1915 standard rates. There is thus a decrease in the certified percentage of nearly 6 per cent. Details of the audit show that the principal cause of the decrease is a reduction in output due to holidays. The Christmas holidays were mainly responsible for a reduction of practically 500,000 tons in the production of the coalfield, as compared with the output in November, and accompanying this decrease in output was an increase in the cost of production.

Dock Appointments.

Genuine regret is felt in coal trade circles that Mr. J. H. Vickery, the chief docks manager for the Great Western Railway Company, is retiring. Mr. Vickery has tendered his resignation, and it will take effect almost immediately. Mr. Vickery has had, altogether, forty-eight years of rail and dock service, and the last few years of that period have been the most strenuous. He was appointed chief docks manager for the Great Western Company on the absorption of the docks into the railway system on the fusion in 1922, and this naturally entailed heavy responsibilities and very hard work, the strain of which has not been without its effect upon him. It is reported that Mr. C. S. Page, who has been assistant general manager at Cardiff since 1920, is likely to succeed him, but for the time being Mr. Edward Lowther has consented to supervise the work of the Great Western Railway docks department. Mr. Lowther, however, who is the chief goods manager of the company, having reached the normal age limit, is retiring from that position.

Current Business.

There has been rather more activity in business during the past week, and the tone is certainly improving. Colliery stems are filling up, and as soon as the tonnage comes up which has been recently chartered, there is likely to be a considerable difference in the prices quoted as compared with those which have lately been accepted by salesmen to get them out of their immediate difficulties owing to the shortage of wagons. Best Admiralty large have recently been worth not more than 29s. to 30s., but already collieries are indicating that they will not accept less than 31s. for supplies for shipment after this week. Small coals are also steadier owing to the temporary stoppages of collieries during the past week or so affecting the quantity of these coals available. In the anthracite section there is evidence that consumers are stocking supplies in case there should be trouble with the miners, and considerable quantities are going inland. Sized coals are certainly steadier. There is practically no change in patent fuel and coke, but pitwood is easier. Prices have come down from 35s., prevailing when the dockers' strike terminated, to 28s. to 29s., this being due to the shortage of empty wagons and the difficulty of effecting the discharge of cargoes.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

WE are informed that the firm of John M. Henderson and Co., of Aberdeen, has been converted into a private joint stock company as from 1st January last, and will be continued as hitherto under the same direction and management.

WE are asked to state that the firm of Electrical Productions, of Excelsior Works, Ellis-street, Birmingham, has secured the whole of the stock, plant, and designs relating to the "Ventex" fuse system, and has arranged for that commodity to be produced on a much larger scale than hitherto.

CONTRACTS.

THERMIT, Limited, has obtained a contract for tram rail welding at Nelson, Lancashire, as well as contracts for similar work at Edinburgh and at Croydon.

GOODWIN, BARSBY AND CO., Limited, of Leicester, inform us that they have just received a repeat order from the Battersea Borough Council for a patented "Acme" stonebreaker.

THOS. W. WARD, Limited, of Sheffield, inform us that they have secured the contract for the steel work, roofing, girder-work, &c., for the re-erection of the Atlas works of Loxley Bros., Limited, which were destroyed by fire last December.

CALENDARS, DIARIES, &c.

AUGUST'S MUFFLE FURNACES, Limited, Halifax.—Wall calendar with monthly tear-off sheets.

EDWARD WOOD AND CO., Limited, Manchester.—Wall calendar with monthly tear-off sheets.

YORKSHIRE TESTING WORKS, Limited, St. Peter's Close, Sheffield.—Wall calendar with monthly tear-off sheets.

C. ISLER AND CO., Limited, Bear-lane, Southwark, S.E. 1.—Wall calendar with views of works carried out by the company.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	19/6 to 26/-
(1) Spanish	23/-
(1) N. African	23/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	24/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	5 2 6	—
No. 1 Foundry	5 6 3	—
No. 3 Foundry	5 1 3	—
N.E. Coast—		
Hematite Mixed Nos.	5 0 0	5 0 0
No. 1	5 1 0	5 1 0
Cleveland—		
No. 1	4 16 0	4 16 0
Silicious Iron	4 15 0	4 15 0
No. 3 G.M.B.	4 13 0	4 13 0
No. 4 Foundry	4 12 0	4 12 0
No. 4 Forge	4 11 0	4 11 0
Mottled	—	—
White	—	—
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	9 2 6	—
North Staffs. Forge	4 10 0 to 4 12 0	
,, ,, Foundry	4 17 6	—
(3) Northampton—		
Foundry No. 3	4 12 6	—
,, Forge	4 6 6	—
(3) Derbyshire—		
No. 3 Foundry	4 14 0 to 4 16 0	
Forge	4 7 6 to 4 10 0	
(3) Lincolnshire—		
No. 3 Foundry	4 15 0	—
No. 4 Forge	4 14 0	—
Basic	4 11 0 to 4 13 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	(5) 5 15 0 (a)	—
	(6) 6 0 0 (b)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	12 10 0	—
Best ,,	—	—
N.E. Coast—		
Common Bars	12 0 0	—
Lancs.—		
Crown Bars	12 10 0	—
Second Quality Bars	11 15 0	—
Hoops	15 0 0	14 15 0
S. Yorks.—		
Crown Bars	12 10 0	—
Best ,,	13 10 0	—
Hoops	14 10 0	—
Midlands—		
Crown Bars	12 10 0	—
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	11 10 0	—
Gas Tube Strip	12 17 6 to 13 0 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	13 10 0	—
Ship Plates, ¼in. and up	10 5 0	—
Sections	10 0 0	—
Steel Sheets, 3/16in. to ¼in.	12 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	18 10 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	10 5 0	—
Angles	10 0 0	—
Boiler Plates	13 10 0	—
Joists	10 0 0	—
Heavy Rails	9 0 0	—
Fish-plates	13 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	10 5 0	—
Soft Billets	9 0 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	9 5 0†	—
Light ,,	9 10 0 to 10 0 0†	
Billets	8 10 0 to 12 0 0†	
Hoops	14 10 0	—
Manchester—		
Bars (Round)	10 10 0 to 10 15 0	
,, (others)	10 5 0 to 10 7 6	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	13 15 0	13 10 0
Plates	10 10 0	—
,, (Lancs. Boiler)	13 10 0	—
Sheffield—		
Siemens Acid Billets	12 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	10 5 0	—
Intermediate Basic	10 0 0	—
Soft Basic	8 5 0 to 8 10 0	
Hoops	12 10 0 to 13 0 0	
Soft Wire Rods	11 10 0	—
Midlands—		
Small Rolled Bars	10 10 0 to 11 0 0	
Billets and Sheet-bars	8 0 0 to 8 5 0	
Gas Tube Strip	10 15 0 to 11 0 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	18 10 0	—
Angles	10 0 0	—
Joists	10 0 0	—
Tees	11 0 0	—
Bridge and Tank Plates	10 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	24/6 to 25/-
Block Tin (cash)	£289 15 0
,, (three months)	£287 0 0
Copper (cash)	£67 15 0
,, (three months)	£68 10 0
Spanish Lead (cash)	£38 0 0
,, (three months)	£36 12 6
Spelter (cash)	£36 7 6
,, (three months)	£36 2 6
Manchester—	
Copper, Best Selected Ingots	£72 0 0
,, Electrolytic	£74 0 0
,, Strong Sheets	£100 0 0
,, Tubes (Basis price)	9 1 1½
Brass Tubes (Basis price)	9 1 0½
,, Condenser	9 1 2½
Lead, English	£39 0 0
,, Foreign	£38 5 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/9 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 10 0	10/6
,, 6 p.c. to 8 p.c. ,,	£23 0 0	8/-
,, 8 p.c. to 10 p.c. ,,	£22 0 0	8/-
,, Specially Refined ,, Max. 2 p.c. carbon	£46 0 0	18/-
,, ,, 1 p.c. ,,	£56 0 0	21/-
,, ,, 0.75 p.c. carbon	£68 0 0	22/6
,, carbon free	1/6 per lb.	
Metallic Chromium	4/2 per lb.	
Ferro Manganese (per ton)	£17 for home, £17 for export	
,, Silicon, 45 p.c. to 50 p.c.	£11 5 0 scale 5/- per unit	
,, ,, 75 p.c.	£18 0 0 scale 6/- per unit	
,, Vanadium	20/- per lb.	
,, Molybdenum	8/6 per lb.	
,, Titanium (carbon free)	1/3 per lb.	
Nickel (per ton)	£130	
Cobalt	11/- per lb.	
Aluminium (per ton)	£82 to £100. (British Official.)	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	26/-
,, ,, Eli	27/-
,, ,, Splint	27/- to 30/-
,, ,, Trebles	26/3
,, ,, Doubles	24/9
,, ,, Singles	22/3
Ayrshire—	
(f.o.b. Ports)—Steam	26/-
,, ,, Splint	27/-
,, ,, Trebles	26/3
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	22/6 to 25/3
Screened Navigation	29/-
Trebles	27/6
Doubles	25/-
Singles	22/3
Lothians—	
(f.o.b. Leith)—Best Steam	24/6
Secondary Steam	23/6
Trebles	27/-
Doubles	25/-
Singles	22/-

ENGLAND.

	Inland.
(8) N.W. Coast—	
Steams	31/-
Household	49/- to 59/-
Coke	41/-
Northumberland—	
Best Steams	26/6 to 27/-
Second Steams	24/6 to 25/-
Steam Smalls	16/6 to 17/-
Unscreened	22/6 to 23/6
Household	26/- to 28/-
Durham—	
Best Gas	26/3 to 28/6
Second	23/6 to 24/-
Household	26/- to 28/-
Foundry Coke	27/6 to 30/-
Sheffield—	Inland.
Best Hand-picked Branch	35/- to 36/- —
Barnsley Best Silkstone	30/6 to 32/- —
Derbyshire Best Brights	30/- to 32/- —
,, ,, House	26/- to 27/- —
,, ,, Large Nuts	24/6 to 25/6 —
,, ,, Small ,,	18/6 to 20/6 —
Yorkshire Hards	25/- to 27/- —
Derbyshire ,,	24/- to 25/- —
Rough Slacks	12/6 to 13/6 —
Nutty ,,	10/- to 13/- —
Smalls	7/6 to 9/6 —
Blast-furnace Coke (Inland)	27/- to 29/-
,, ,, (Export)	f.o.b. 35/- to 36/-

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	29/6 to 31/-
Second ,, ,,	29/- to 30/-
Best Dry Large	28/6 to 29/-
Ordinary Dry Large	27/- to 28/-
Best Black Vein Large	29/- to 29/-
Western Valley ,,	27/6 to 28/6
Best Eastern Valley Large	27/- to 28/-
Ordinary ,, ,,	26/- to 27/-
Best Steam Smalls	20/- to 21/-
Ordinary ,,	18/- to 20/-
Washed Nuts	28/- to 30/-
No. 3 Rhondda Large	29/- to 30/-
,, ,, Smalls	25/- to 26/-
No. 2 ,, Large	24/- to 25/-
,, ,, Through	21/- to 23/-
,, ,, Smalls	19/- to 20/-
Coke (export)	52/6 to 57/6
Patent Fuel	30/- to 32/6
Pitwood (ex ship)	28/6 to 29/-
Swansea—	
Anthracite Coals:	
Best Big Vein Large	40/- to 45/-
Seconds	32/6 to 35/-
Red Vein	30/- to 31/-
Machine-made Cobbles	47/6 to 52/6
Nuts	50/- to 55/-
Beans	40/- to 47/6
Peas	26/- to 27/-
Breaker Duff	12/9 to 13/3
Rubbly Culm	14/6 to 15/-
Steam Coals:	
Large	24/6 to 25/-
Seconds	22/- to 23/-
Smalls	14/- to 16/-
Cargo Through	19/- to 21/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow.

(8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

† Latest quotations available. (a) Delivered Sheffield or Glasgow. (b) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

The Industrial Position.

As soon as there was an appreciable increase in the supplies of coke from the Ruhr, and the larger consignments available for distribution appeared likely to put an end to the long period of shortage, it was fully expected that prices would come down sufficiently to influence the values of iron and steel. It was believed even that a year of inflated prices would be followed by a strenuous competition, when manufacturers would be obliged to make desperate efforts to dispose of their surplus production in foreign markets. So far is this from being the case, that coke prices are still being maintained, and the values of iron and steel products are advancing, this being due, of course, to the heavy depreciation of the franc, which has enormously increased the cost of fuel and material purchased abroad. The result of this state of things is that iron and steel prices are advancing much more rapidly than they are elsewhere, although the monetary depreciation still leaves them relatively much lower than British prices. Consequently, if the franc should continue to fall in value and prices should increase at the rate they are doing at present, a point will soon be reached where any sudden improvement in the franc would leave the French manufacturer in the position of not being able to compete for business at all. Makers cannot quote down prices before absorbing the stocks of material purchased at the higher rates. The advancing prices have not had any effect in restricting activity, partly because producers themselves hesitate to commit themselves forward on a rising market, while buyers are all the more anxious to place orders. The only restraining influence on trade is the suspension of all new public works for which money has to be provided by the State. Heavy constructional work is suffering especially from the financial retrenchment, but in many branches of the engineering industry there continues to be plenty of activity, notably amongst the machine tool and motor car firms. Nevertheless, there is a strong element of instability in the situation generally through failures, labour agitation and absence of credits.

Reconstruction Work.

The failure of the Government to fulfil its obligations to pay for work done in the liberated regions, has for a long while past caused serious trouble amongst contractors and engineering firms which have been supplying material in exchange for certificates that the State has not always been able to redeem, and the situation is now further complicated by the decision of the Government to reduce the amount to be spent upon reconstruction work, in accordance with the policy recently adopted by the Cabinet not to sanction any expenditure for which there is no corresponding revenue. At a meeting of contractors and architects last week, it was pointed out that this policy would result in at least two-thirds of the 280,000 hands employed in the liberated regions being obliged to seek work elsewhere. That would not appear to present any serious difficulty, for one of the causes of the labour scarcity and the advancing wages is the special inducement offered to men to work in the liberated regions, and if they were released, it is evident that the situation would become much easier in other industrial centres. The contractors and architects, however, complain that as no further funds are being devoted by the Government to the carrying out of public undertakings, there will be a scarcity of work for the men who are obliged to leave the liberated regions, while they also point to the trouble of finding lodging accommodation for them; but, on the whole, it is generally recognised that a slowing down of activity in reconstruction work will have a satisfactory effect upon the labour situation elsewhere.

Commercial Treaties.

The rejection by the Belgian Chamber of Deputies of the proposed Franco-Belgian commercial arrangement, with the consequent fall of the Ministry, is attributed to other reasons besides the purely economic relations between the two countries; but the fact that the proposed convention has been strongly attacked for many months past proves that the system of partial treaties inaugurated by France is not sufficiently pliable to give general satisfaction. The system aims at facilitating the importation of goods which do not compete with home productions, in return for special advantages in favour of French manufactures and products, and as the industrial development of France now covers nearly everything there is really little that this country can offer in return for concessions. The negotiations for the treaty therefore consisted in a long term of bargaining, in which the Belgians consider that they have got the worst of the deal, in the sense that the treaty was regarded as bringing them under the economic domination of France, and feeling that they were losing their commercial independence without any gain, the Belgians have rejected the treaty as incompatible with their situation as an industrial nation. Except in the case of Canada, the French have failed to negotiate treaties on this basis with any great industrial country.

Rail Motor Cars.

The success of the experiments with petrol rail motor cars on the secondary lines, which do not provide enough traffic to enable trains with steam locomotives to pay their way, appears to be so pronounced that several more petrol vehicles are being put into service. In addition to the petrol rail cars constructed by Schneider et Cie. and the Etablissements Baudet, Donon et Cie., some Renault-Scemia motor vehicles have been running satisfactorily in some of the northern departments. Now, as the result of tests carried out with rail motors constructed by Berliet, or Lyons, it is understood that a service of such vehicles is to be started in the Marseilles district. It is declared that the various types of rail motor cars have abundantly proved that it is possible to run regular services on secondary lines at a profit.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

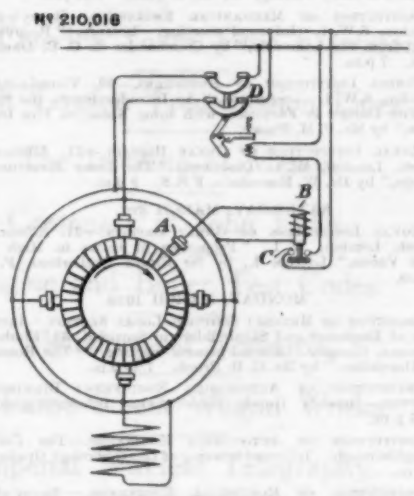
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

210,018. June 26th, 1923.—IMPROVEMENTS IN AND RELATING TO DYNAMO-ELECTRIC MACHINES, *The British Thomson-Houston Company, Limited, Crown House, W.C. 2.*

This invention is very easily described. Its object is to prevent flashing-over between the brushes of electrical machines. Between the brushes there is a conducting member A, such as

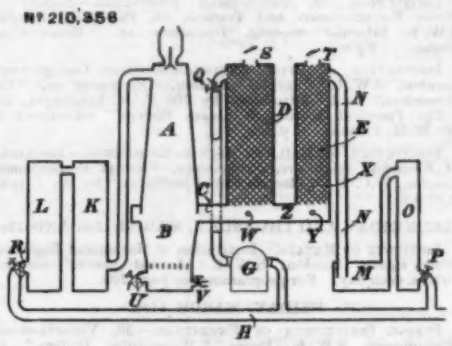


a rod of carbon, which is placed in close proximity to the commutator, but which does not touch it. In the event of flashing, the relay coil B is energised, and as a result of the contacts C being closed the tripping coil of the circuit breaker D is energised and the breaker opens and inserts resistance in the main circuit, or in the field circuit.—*January* 24th, 1924.

GAS PRODUCERS.

210,356. June 29th, 1923.—APPARATUS FOR THE MANUFACTURE OF GAS FROM COAL, M. W. Travers, 11, Aldwych, London, W.C. 2, and F. W. Clark, Fieldhead, Maltmans-road, Lymm, Cheshire.

In the diagram accompanying this specification A is the carbonisation chamber and B the gasification chamber. C is a passage through which the blow gases pass from B to the bottom of a regenerator D filled with brick chequer work and provided with a stack valve S and a secondary air inlet W. U and V are valves for admitting air and steam respectively beneath the chamber B. During the run gas passes from the top of chamber A through a scrubber K and condenser L past a valve R to the main H which leads to the gasholder. From a convenient point in the main H a by-pass leads to a circulator G adapted to force some of the gas from the main past a valve Q to the top of the regenerator D. E is the enriching chamber which, like the regenerator, is filled with brick chequer work and communicates by a passage Z with the regenerator D at any convenient level. If preferred the passage Z may communicate

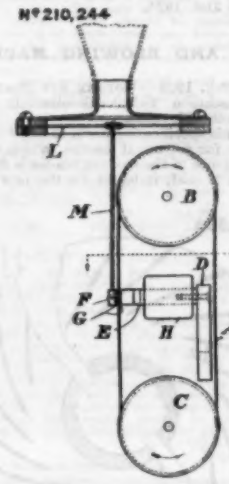


directly with the passage C. In the bottom of the chamber E is a secondary air inlet Y by which air can be introduced to complete the combustion of the blow gas as it passes up from the chamber E to the stack valve T. X is a sprayer for introducing oil into the chamber E from the top of which a pipe N leads to a wash box M. From this box the enriched gas issues to a cooler O and so through a valve P to a point in the main between the intake of the circulator G and the gasholder. In operating the plant the valves P, Q and R are first closed, the stack valves S and T and the air-blast valve U are opened and air is blown into B till the temperature is raised sufficiently for the production of water gas by subsequent steaming. During this operation the blow gas, containing carbon dioxide and carbon monoxide, passes through the channel C and is distributed through the vessels D and E in proportions which can be regulated by restricting the openings of S and T. Secondary air may be admitted at W and Y. Thus the temperatures to which the vessels D and E are raised during the blow period can be controlled and regulated. At the end of the blow period the secondary air is cut off at W and Y and the air blast valve U is closed. The steam valve V is opened, the stack valves S and T are closed, and the valves P and R are opened. The circulator G is set in motion, the valve Q is opened, and oil is sprayed into E by the sprayer X. The water gas generated in B passes upwards through the coal in A, and, with the gas produced by the distillation of the coal, passes through the scrubber K and the condenser L to the main H. Some of this gas is forced by the circulator G to the top of the regenerator D, and passes through it, being heated in the process. The stream of gas divides at the bottom of the regenerator. Part of it enters the bottom of the carbonisation chamber A through the channel C and part of it passes through the channel Z into the bottom of the carburetter E and flows upwards together with the sprayed oil, which, in contact with the hot brick work, and by the action of the hydrogen in the gas, is converted into permanent hydrocarbon gas. The enriched gas passes through the pipe N, the wash box M, the cooler O and the valve P to the main H, and as the quantity of gas passing the valve P can be controlled, the quantity of gas entering the carburetter E is also under control. As during the gasification period there is a continuous flow of gas from left to right in the diagram along the main H the enriched gas cannot travel in the contrary direction, and the gas taken in by the circulator consists only of coal gas diluted with water gas. Only gas of this character is used for the regenerative heating of the coal in the carbonisation chamber, and the enriched gas is subjected only to the temperature which is maintained in the carburetter, and not to the higher temperature which it may be necessary to maintain at the bottom of the carbonisation chamber in order to work this part of the plant at its maximum efficiency. Further the quantity of gas circulated is quite independent of the quantity of gas passing through the carburetter.—*January* 21*st*, 1924.

TELEGRAPHS AND TELEPHONES.

210,244. December 14th, 1922.—IMPROVEMENTS IN OR RELATING TO ELECTRO-MAGNETIC SOUND RECEIVING AND PRODUCING DEVICES, Cecil Wilfrid Clarabut, of 73, Beverley-crescent, Bedford.

This invention relates to electromagnetic sound receiving and producing devices and has for its primary object the provision of simple and novel means whereby an electro-magnetic flux which is varied in accordance with given sound vibrations will be enabled to produce corresponding sound vibrations of greater amplitude than has heretofore been possible. An endless band A passes over two spaced pulleys B C, one of which being driven by external motive power in the direction of the arrow. A magnet D comprising pole pieces E and an armature F, faced with cork or other friction material, is separated from the pole pieces by a gap G, and is provided with operating coils H. Through the gap G the endless band A passes, and it is

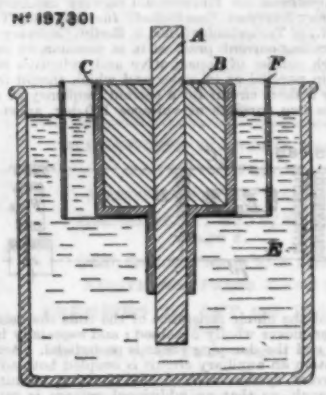


in frictional contact with armature F, and the pole pieces E, of the magnet. A vibratory diaphragm L is mounted on the base of a trumpet or other sound-directing device, and is provided at its centre with a nut, to which a wire M is attached, the remote end of which is connected to the armature. With this arrangement the magnet will attract its armature to a greater or less extent in accordance with variations of current in the operating coils H, thus varying the pressure and hence the frictional dragging force between the band A and the armature F, which will attempt to move to a greater or less extent in unison with the band A. In this way varying vibrations corresponding to the varying current in the operating coils H will be transmitted by means of the wire M to the diaphragm, which will thus reproduce in an amplified form the sounds which originally caused the operating coil current to vary.—*January* 31*st*, 1924.

BATTERIES AND ACCUMULATORS.

197,301. March 13th, 1922.—IMPROVEMENTS IN ELECTRIC BATTERY CELLS, Société Anonyme le Carbone, of Nos. 12 and 33, rue de Lorraine, Levallois-Perret (Seine), France.

This invention has for its object to provide an improved



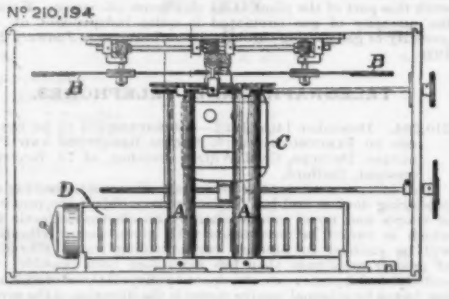
electric battery cell wherein the precipitates and insoluble products formed during its working are concentrated and localised. The positive electrode comprises a central carbon A which is a good conductor of electricity and which carries a porous

conducting body B consisting, for instance, of an agglomerate of wood charcoal. The height of the porous body is less than that of the carbon conductor A, which extends upwards and downwards beyond the porous body. The upper end of the central carbon A and the upper portion of the porous body B project above the electrolyte so as to be in contact with the atmosphere. A covering C of colloidal substance covers the whole of the surface of the porous body B that is liable to be in contact with the electrolyte. This colloidal covering stops at a certain distance above the lower end of the carbon A. The electrolyte E consists of ammonium chloride. The negative electrode is composed of zinc F coiled in cylindrical shape.—*January 31st*, 1924.

MEASURING AND TESTING INSTRUMENTS.

210,194. November 7th, 1922.—Stroboscopic Apparatus, L. A. G. Grant, 97, New Oxford-street, London, W.C. 1.

This apparatus is intended for use in viewing moving machinery, and has the effect of making the parts to appear as stationary. A A are two binocular tubes through which the object is viewed, and in front of them there are two discs B B. These discs are driven by the motor C, through the gearing shown,

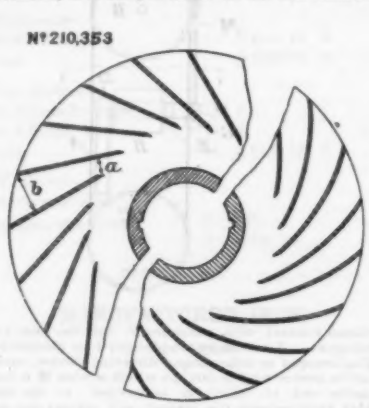


and each has an aperture, in its circumference, the area of which can be adjusted. These apertures allow the object to be seen only as it passes in front of the binocular tubes. By adjusting the speed of the motor, with the aid of the rheostat D, the moving object can be made to appear as stationary or moving slowly.—*January 31st*, 1924.

PUMPING AND BLOWING MACHINERY.

210,353. June 20th, 1923.—Rotary Air Compressors, Erste Brünner Maschinen Fabriks-Gesellschaft Glockengasse, 5, Brünn, Czecho-Slovakia.

The claims in this specification seem to be of a very sweeping character and are for a "noval feature, which consists in that the ratio of divergence of the moving blades is 2.2 to 1 or less." The invention, it is said, is based on the new discovery that

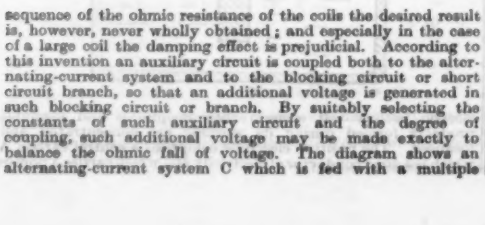


the most important factor in the efficiency of a rotary compressor is the divergence ratio $\frac{b}{a}$ of the blades, and that the maximum efficiency of a compressor is obtained when the divergence ratio $\frac{b}{a}$ does not exceed a predetermined upper limiting value. The upper limiting value for the expansion ratio $\frac{b}{a}$ is 2.2 to 1. By the invention the advantage is attained that diffusor action commences in the blade cells of the runners themselves, whereas in known rotary compressors only the cells of the guides produce a diffusor action.—*January 31st*, 1924.

MISCELLANEOUS.

205,485. October 5th, 1923.—Improvements in or relating to Acceptor or Rejector Circuits in Alternating-current Systems, Gesellschaft für drahtlose Telegraphie m.b.H., of Tempelhofer Ufer, 9, Berlin, Germany.

In alternting-current practice it is common to employ circuits which consist of capacitative and inductive impedances arranged in parallel or in series and which should form either a block or a short circuit for a certain frequency or may serve to produce two currents or voltages 180 deg. apart. In con-



sequence of the ohmic resistance of the coils the desired result is, however, never wholly obtained; and especially in the case of a large coil the damping effect is prejudicial. According to this invention an auxiliary circuit is coupled both to the alternating-current system and to the blocking circuit or short circuit branch, so that an additional voltage is generated in such blocking circuit or branch. By suitably selecting the constants of such auxiliary circuit and the degree of coupling, such additional voltage may be made exactly to balance the ohmic fall of voltage. The diagram shows an alternating-current system C which is fed with a multiple wave current from a generator D. For one frequency a short circuit branch B is arranged in parallel, for another frequency a blocking circuit A is inserted in the line, and a complete short circuiting or a complete block is obtained by the insertion of the auxiliary circuits E, F. By this invention a complete blocking system for one frequency is obtained, and two currents or voltages are produced differing exactly 180 deg. in phase.—*January 31st*, 1924.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institute of Metals: Sheffield Local Section.—The University, St. George's-square, Sheffield. Paper, "Some Aspects of Alloy Plating," by Mr. S. Field. 7.30 p.m.

Institution of Mechanical Engineers.—Storey's-gate, London, S.W. 1. Informal meeting. Lecture, "Recovering Gold from the Laurentic," by Commander G. C. C. Damant, R.N. 7 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Lecturette, "An Introduction to the Study of Fire Danger in Factories, with some Notes on Fire Insurance," by Mr. P. M. Fraser.

Royal Institution of Great Britain.—21, Albemarle-street, London, W. 1. Discourse, "The Inner Structure of Alloys," by Dr. W. Rosenhain, F.R.S. 9 p.m.

SATURDAY, MARCH 8TH.

Royal Institution of Great Britain.—21, Albemarle-street, London, W. 1. "Properties of Gases in High and Low Vacua," Lecture I., by Sir Ernest Rutherford, F.R.S. 3 p.m.

MONDAY, MARCH 10TH.

Institute of Metals: Scottish Local Section.—Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Annual general meeting. "The Romance of Aluminium," by Mr. G. B. Brook. 7.30 p.m.

Institution of Automobile Engineers: Birmingham Centre.—Queen's Hotel, Birmingham. Informal meeting. 6.45 p.m.

Institution of Automobile Engineers.—The College, Loughborough. Informal meeting of Loughborough Graduates. 7 p.m.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, London, W.C. 2. Informal meeting. A discussion on the work of the International Conference on E.H.T. Lines, held in Paris in November last, will be opened by Monsieur J. Tribot Laspière. 7 p.m.

Surveyors' Institution.—12, Great George-street, London, S.W. 1. Paper, "Economic Effects of the Housing Subsidy and Rent Restriction Acts," by Mr. J. Calvert Spensley. 8 p.m.

TUESDAY, MARCH 11TH.

Institute of Marine Engineers.—85-88, The Minories, London, E. 1. "A Note on the Air Supply to the Larger Type of Motor Vessel," by Captain P. T. Brown. 6.30 p.m.

Institution of Automobile Engineers: Coventry Centre.—Railway Hotel, Coventry. Discussion on "Lamps for Winter Driving." 7 p.m.

Institution of Electrical Engineers: Scottish Centre.—North British (Waverley) Station Hotel, Edinburgh. Paper, "The Design of Apparatus for the Protection of Alternating-current Circuits," by Mr. A. S. FitzGerald. 7 p.m.

Institution of Petroleum Technologists.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Annual general meeting. Address by the President, Mr. H. Barringer. 6 p.m.

Manchester Geological and Mining Society.—Queen's Chambers, 5, John Dalton-street, Manchester. Paper, "Electric Winders," by Mr. D. Weir. 4 p.m.

WEDNESDAY, MARCH 12TH.

Institute of Metals.—The Trocadero, Piccadilly-circus, London, W. 1. Annual dinner. 7.15 for 7.30 p.m.

Institution of Automobile Engineers.—Society of Motor Manufacturers and Traders, 83, Pall Mall, London, S.W. 1. Informal meeting. Discussion on "Motor Cycle Brakes." 6 p.m.

Institution of Civil Engineers.—Great George-street, London, S.W. 1. Informal meeting. Discussion on, "CO_2 Recorders," to be introduced by Mr. C. E. Stromeyer, and "The Practical Testing of Steam Boilers," introduced by Mr. R. H. Parsons. 7 p.m.

Institution of Railway Signal Engineers.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, London, W.C. 2. "Electric Signal Machines," by Mr. J. Boot. 6.30 p.m.

WEDNESDAY AND THURSDAY, MARCH 12TH AND 13TH.

Institute of Metals.—Institution of Mechanical Engineers, Storey's-gate, London, S.W. 1. Annual general meeting. 10 a.m. each day. For programme see page 208.

FRIDAY, MARCH 14TH.

Junior Institution of Engineers.—39, Victoria-street, Westminster, S.W. 1. Paper, "Water-tube Boilers," by Mr. L. M. Jockel. 7.30 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, London, W. 1. Discourse, "The Pilgrim's Progress," by Dr. J. W. Mackail. 9 p.m.

SATURDAY, MARCH 15TH.

Institute of Metals: Swansea Local Section.—Metallurgical Department, University College, Singleton Park, Swansea. General Discussion. 7.15 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, London, W. 1.—"Properties of Gases in High and Low Vacua" (Lecture II.), by Sir Ernest Rutherford, F.R.S. 3 p.m.

SATURDAY TO SATURDAY, MARCH 15TH TO 22ND.

Marine and Small Craft Exhibition at the Royal Agricultural Hall, Islington, London, N. 1.

MONDAY, MARCH 17TH.

Institution of Automobile Engineers: Scottish Centre.—Royal Technical College, Glasgow. Paper, "Some Notes on Four-wheel Braking Systems," by Mr. F. A. S. Acres. 7.30 p.m.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, London, W.C. 2. Informal meeting. Discussion on "Illuminating Engineering, its Application and Value to the Electrical Industry," opened by Messrs. Leon Gaster and J. S. Dow. 7 p.m.

Institution of Structural Engineers.—Criterion Restaurant, London, W. 1. Annual dinner. 7 for 7.30 p.m.

University of London.—Institution of Civil Engineers, Great George-street, London, S.W. 1. "Practical Hydraulic Engineering Problems in Connection with Navigation." Lecture IV.: "Harbour Engineering Abroad," by Mr. O. C. A. Van Lidth de Jeude. 5 p.m.

TUESDAY, MARCH 18TH.

Institute of Marine Engineers.—85-88, The Minories, Tower Hill, London, E. 1. "The Development of the Marine Steam Turbine," by Mr. G. W. Johnson. 6.30 p.m.

Institution of Automobile Engineers.—Broadgate Café, Coventry. Coventry Graduates' meeting. Paper, "Service Organisation," by Mr. J. H. Boxall. 7.15 p.m.

Institution of Automobile Engineers: Wolverhampton Centre.—Star and Garter Hotel, Wolverhampton. Paper, "Some Notes on Four-wheel Braking Systems," by Mr. F. A. S. Acres. 7.30 p.m.

Institute of Metals: Birmingham Local Section.—Chamber of Commerce, New-street, Birmingham. Paper, "Brittle Ranges in the Brasses," by Mr. D. Bunting. 7 p.m.

WEDNESDAY, MARCH 19TH.

Institution of Automobile Engineers: North of England Centre.—Hotel Metropole, Leeds. Paper, "Steam Wagon Design and Portable Lines of Development for Home and Colonial Service," by Mr. T. Clarkson. 6.30 p.m.

Institution of Automobile Engineers.—Chamber of Commerce, New-street, Birmingham. Birmingham Graduates' meeting. Paper, "Clutches," by Mr. G. Corbett. 7.30 p.m.

University of London.—Institution of Civil Engineers, Great George-street, London, S.W. 1. "Practical Hydraulic Engineering Problems in Connection with Navigation." Lecture V.: "Shipping Conditions in Port," by Mr. O. C. A. Van Lidth de Jeude. 5 p.m.

THURSDAY, MARCH 20TH.

Institute of Metals: London Local Section.—Institute of Marine Engineers, 85-88, The Minories, London, E. 1. Open discussion. 8 p.m.

Institution of Automobile Engineers.—Watergate House, Adelphi, London, W.C. 2. London Graduates' meeting. Paper, "Brake Shoe Design," by Mr. H. E. Merritt. 7.30 p.m.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, London, W.C. 2. Lecture on "The Nature and Reproduction of Speech Sounds (Vowels)," by Sir Richard Paget. 6 p.m.

FRIDAY, MARCH 21ST.

Ex-British Westinghouse Association.—Holborn Restaurant, London, W.C. 1. Sixth annual re-union dinner. 5.45 for 6.45 p.m.

Institute of Marine Engineers.—Hotel Victoria, Northumberland-avenue, London, W.C. 2. Annual conversazione. 6.30 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Lecturette, "Sulphuric Acid Plants, New and Old; Constructional Details and Working," by Mr. P. Parrish. 7.30 p.m.

University of London.—Institution of Civil Engineers, Great George-street, London, S.W. 1. "Practical Hydraulic Engineering Problems in Connection with Navigation." Lecture VI.: "The Zuiderzee Scheme," by Mr. O. C. A. Van Lidth de Jeude. 5 p.m.

SATURDAY, MARCH 22ND.

Institution of Automobile Engineers.—London Graduates' visit to the brewery of Watney, Combe, Reid and Co., Allingham-street, London, S.W. 1. 2.30 p.m.

TUESDAY, MARCH 25TH.

Institute of Marine Engineers.—85/88, The Minories, Tower Hill, London, E. 1. "Some Notes on the Theory of Lubrication, with Particular Application to the Michell Thrust," by Mr. J. Ward. 6.30 p.m.

Institution of Automobile Engineers.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Annual general meeting. Paper, "Balancing of Automobile Engines," by Mr. H. S. Rowell. 6.30 p.m.

THURSDAY, MARCH 27TH.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, London, W.C. 2. "The Future of Main Line Electrification on British Railways," by Lieut.-Colonel H. E. O'Brien. 6 p.m.

Royal Aeronautical Society.—7, Albemarle-street, London, W. 1. Annual general meeting. 5 p.m.

WEDNESDAY, APRIL 9TH.

Institution of Naval Architects.—Connaught Rooms, Great Queen-street, London, W.C. Annual dinner. 7.30 p.m.

WEDNESDAY TO FRIDAY, APRIL 9TH TO 11TH.

Institution of Naval Architects.—Royal United Service Institution, Whitehall, London, W.C. 2. Annual general meetings.

The Institution of Automobile Engineers.—The Institution of Automobile Engineers has been fortunate in having two more valuable prizes offered to it; the first is one of £50, presented by the Humber Company to mark the year of office as president of Mr. H. G. Burford, who did so much for that company in its early days. The Council has decided to offer this prize for the best paper which may be submitted by anyone, whether a member or not, dealing with the points necessary in the design of a car to meet colonial conditions. The paper which is awarded the prize will be read at the Joint Conference held by the Society of Motor Manufacturers and Traders and the Institution at the British Empire Exhibition at Wembley in June. The paper may deal either with the motor car, the commercial vehicle or vehicles of the track laying type. The second of the above prizes is one of £20 offered annually by the *Automobile Engineer*, for the best contribution to the discussion on any paper read by a senior member, while a further prize of books to the value of £5 5s., will be given to the graduate who makes the best contribution to the discussion on any paper read by a senior member.